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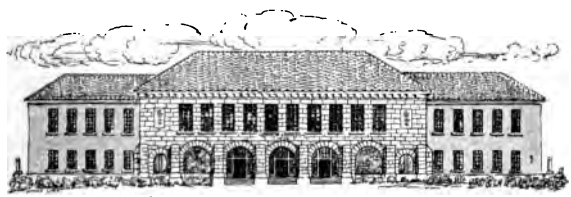

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MARY WOOD-ALLEN.

THE
MAN WONDERFUL

The Marvels
of our
Bodily Dwelling

Mary Wood-Allen, M. D.

EDUCATIONAL PUBLISHING COMPANY
Boston
New York Chicago San Francisco

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PREFACE.

"MENS sana in corpore sano," is a sentence with which we were familiar forty years ago. We repeated it glibly in the original and could translate it into equivalent English, "A sound mind in a sound body," but had little comprehension of its full import which even now is but beginning to dawn upon the world. Illnesses were then considered dispensations of Providence; we are now coming to see that we are responsible not only for our own vigor but for that of coming generations. Thus the practical value of physiology is recognized, and nearly every State in the Union has passed a law compelling its study in the public schools. To make it interesting, therefore, is worthy the attention of educators.

Teaching by metaphor, parable, and allegory has been the method of many of the wisest teachers. It is said of Jesus that "without a parable spake he not unto them," so we may hold it as not beneath the dignity of instructors

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of to-day to use the same manner of presenting the truth.

No one can claim originality in comparing the body to a house, for that comparison is as old as literature. Ecclesiastes refers to "the day when the keepers of the house shall tremble and those that look out of the windows be darkened and the door shall be shut in the streets." Abernethy uses a homely figure when he says, "The kitchen — that is, your stomach — being out of order, the garret — the head — cannot be right, and every room in the house becomes affected. Remedy the evil in the kitchen, and all will be right in parlor and chamber."

We quote from Tennyson's "Deserted House:"

"Life and Thought have gone away
Side by side,
Leaving door and windows wide:
Careless tenants they.

"All within is dark as night:
In the windows is no light;
And no murmur at the door,
So frequent on its hinge before."

The author in this volume has united metaphor with scientific facts, and even in this she cannot claim originality. Early in the present century Alcott wrote of "The House We Live In," and later writers on physiology have followed

in his footsteps. But the simile is still of interest to the juvenile mind and, as science is ever making discoveries, there is a demand for new and interesting works on physiology.

The author would be glad to acknowledge all sources of information, but that would be an almost endless task. She has laid under contribution the latest scientific authorities and believes that this book will be found abreast of the science of to-day, holding ever to truth as it now presents itself, and never sacrificing facts to the allegory.

The book is intended for home use or as a supplementary reader, text-book, or reference book in schools.

With thanks to the friends whose words of appreciation have given her encouragement, and to the dear daughter whose quick intelligence and willing fingers have ever been at her command, the author presents this book to the public with the prayerful hope that it may awaken a deep and living interest in this marvelous mansion, stimulating to such study of and obedience to the laws of physiology as will insure that sound body which is the beautiful dwelling-place of a sound mind.

MARY WOOD-ALLEN.

Ann Arbor, Mich.

PREFACE TO FOURTH EDITION.

When a writer offers a new work to this poor book-ridden world it must be with some trepidation and a feeling that an apology would be appropriate.

But when the work has been accepted by the public and new editions are called for, the writer may certainly feel that the responsibility now rests with those who have made the demand.

It is with much pleasure that the author offers the present edition of this volume to a public which has been most generous in its reception of the book in its previous editions.

It is now revised, new illustrations have been added, and it is made altogether more attractive and worthy of commendation.

Many thanks are due to the services of Mr. R. D. Clippinger who, from his coign of vantage, has been able to assist in comparing statements and making them harmonize with the present advancement of science.

So with the new century the book, in a new dress goes forth bearing with it the heartfelt thanks of the author to all who have been its friends in the past and an earnest wish that the circle of kindly readers will widen with the years.

MARY WOOD-ALLEN.

Ann Harbor, Michigan.

Remember now thy Creator in the days of thy youth, while the evil days come not, nor the years draw nigh, when thou shalt say, I have no pleasure in them; while the sun, or the light, or the moon, or the stars, be not darkened, nor the clouds return after the rain. In the day when the the keepers of the house shall tremble, and the strong men shall bow themselves, and the grinders cease because they are few, and those that look out of the windows be darkened, and the doors shall be shut in the streets, when the sound of the grinding is low, and he shall rise up at the voice of the bird, and all the daughters of musick shall be brought low. Also when they shall be afraid of that which is high, and the almond tree shall flourish, and the grasshopper shall be a burden, and desire shall fail: because man goeth to his long home, and the mourners go about the streets: or ever the silver cord be loosed, or the golden bowl be broken, or the pitcher be broken at the fountain, or the wheel broken at the cistern. Then shall the dust return to the earth as it was: and the spirit shall return unto God who gave it.

Eccl. 12: 1–7.

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THE TAJ MAHAL.

CHAPTER I.

INTRODUCTORY.

A GREAT many, many years ago, people thought they could see each other and—you think we see each other now, do you, Master Know-all? You will probably be surprised when I tell you that you never saw any one in your life, and no one ever saw you. How do we know each other then, you ask?—Why, by our houses, of course. We see a light in the window, or hear a voice from the open door, and know that the person is at home, but we never see him. Another strange thing is that our houses are all built after the same plan, have each just so many rooms, arranged in just the same order, with just the same number of doors and windows. You shake your head as if you scarcely believed me, but I assure you I am telling you only the truth. You, the real, thinking, enjoying, knowing you, are shut up in your house, and will never go out of it as long as you live on the earth.

You entered this house when it was very small, and found yourself a prisoner in it. I fancy you did not like it very well, for you cried out for help,

and a good fairy named Aura rushed into your house and took possession of one of the empty rooms, and has made her home there ever since. With Aura came the gift of earthly life. May be you will better understand me if I tell you that Aura is the Latin name for air.

Have you ever taken much interest in learning about your body and how to keep it in good repair? If a man builds a house of brick or stone, he is interested in keeping it in order; he insures it against fire, and if the roof leaks or a window is broken, he does not think it an evidence of good sense to be indifferent, but he calls the roofer or glazier at once to repair damages; and yet he could pull this house down and rebuild it, he could sell it or give it away, or he could move out and leave it to take up his abode in another dwelling; but he can never have but one bodily house, and this he cannot sell nor give away. He can tear it down, but he cannot rebuild it, and when he moves out and leaves it, he is done with earthly life. It is, therefore, very important that he should study this wonderful house and its needs, so that he may know how to keep it in repair for many years of happy, useful occupancy.

Let us study the body as a house in which we dwell here on earth, a house built by a divine Architect, fitted up with every comfort, divided

into many rooms, each with its own appropriate furniture and adapted to its own especial use. It is a beautiful building, more exquisitely adorned than any structure of man's creation.

In India is a wonderful building called the Taj Mahal, and people journey from the farthest parts of the earth to gaze with admiring awe upon its magnificence. It took twenty thousand workmen seventeen years to build it, and it is said to have cost fifty millions of dollars. Still, after all, it is only a tomb, erected by the Emperor Shah Jehan in memory of the Empress Momtazi Mahal, his beautiful, cultured, and beloved wife.

But your bodily house is more marvelous and beautiful than the Taj Mahal. Its design is more wonderful and complicated, its decorations more exquisite, its value far greater. Then, too, it is not a tomb, not a useless monument to a dead empress, but it is the abode of an immortal being in which he finds shelter, a being who is made but little lower than the angels and whom the Great Creator has crowned with honor.

Through the beautiful windows of Man's marvellous house we may catch a glimpse of the light he has kindled by the glow of divine love or the fire of base passion. Through its doorway of speech issues the voice of sweet music or the discordant note of anger that betrays the feelings of

the occupant. Its messengers run to and fro on errands of mercy or business; its servants obey the commands of the master and minister to his needs. Its structure embodies wonders of mechanism, skill of engineering, and prophesies the improvements of modern science. It is the oldest, the most beautiful, the most perfect dwelling ever built.

It is not only a dwelling, but a wonderful workshop, where man does many wonderful things; a laboratory wherein many marvellous processes are carried on; a manufactory where worn-out materials are destroyed and new substances created.

In its secret chambers of thought originate the marvels of poetry, music, art, and literature that proclaim Man worthy of the honor with which he is crowned.

As it is only through his house that Man becomes acquainted with the outside world, and only by means of it is he able to carry out the projects which his mind conceives, it behooves him to learn its powers, cultivate its organs, study its laws, and reverence its Creator.

CHAPTER II.

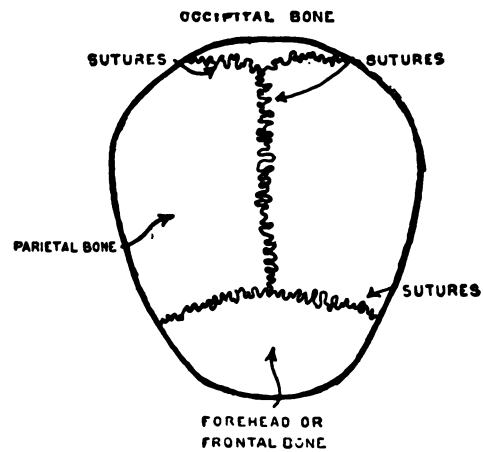
THE FRAME-WORK.

DID you ever see a house walk? I saw one moving along the street the other day, but it was not going very fast. An old colored man, who was once asked how he was progressing on his heavenward way, replied that he was "inching along." That was the way this house progressed, although there were ropes and wheels and boards and rollers and a man and a horse to assist it.

Our bodily house is four stories high, but by means of mechanical contrivances it can walk, or run, or turn handsprings, or climb trees, or dive into the water, or turn itself upside down and stand on the upper story.

About two hundred pieces of a material called bone are united to form the frame-work of the house. These pieces are long, short, flat, or irregular in shape, and when all are fastened together, they form what is called the "skeleton." You know that boards may be united by splicing, dovetailing, or mortising, or by means of contrivances

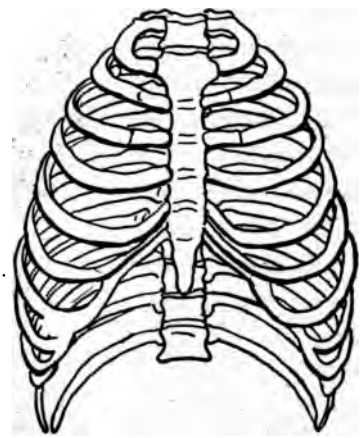
that hold them close together and yet permit easy motion between them. We find the same methods of union in the frame-work of the bodily house.



The dome of the topmost story is formed of many pieces of bone united by dove-tailing or by splicing.

The third story, called the thorax, has a frame-work of curved beams which we commonly speak of as the ribs. These are twelve in number and in the back are attached to the spine. The upper seven of them on each side are fastened to a bone in front known as the sternum, or breast bone. The next three are attached to the seventh by cartilage, and the lower two are fastened to the

spine only, the front ends not being attached to anything. Hence they are called floating ribs.



THORAX.

From the thorax rises the short tower of the neck, which supports the upper story or head. The second story is called the abdomen and its only bony structure is the spine. The lowest story of all is called the pelvis and has a large bony frame, solid and strong, for it not only has to support the stories above, but to it are attached the jointed stilts, or legs, which carry the house about.

Our residences are often adorned with columns; our bodily dwelling has but one, called the spinal column, but that is of great importance. It unites the four stories and forms part of the frame-work

of the three lower stories. The spinal column is long and flexible and composed of twenty-six bones; in shape they are like short spools with handles on one side, and are set one on the other, the handles all pointing the same way. I said one on the other, but, in reality, there are cushions of cartilage between each two bones, and this is what makes it possible to bend the column, for the cushions will yield on pressure. You see that everything about the framework of our house is arranged to allow motion. The spine is not straight, but curves something like an elongated letter S, and this makes a sort of spring which yields to the shock of jumping and walking, and prevents the furniture and machinery in the differ-

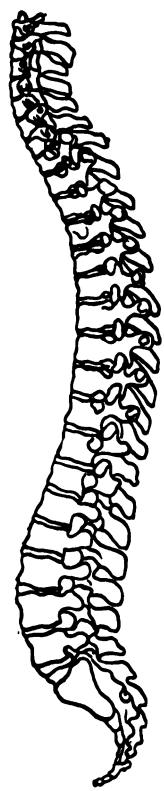
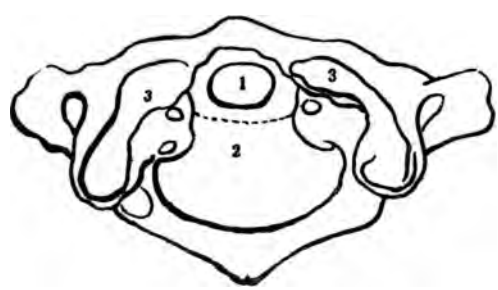


DIAGRAM OF SPINE.

ent rooms from being jarred out of place or otherwise injured.

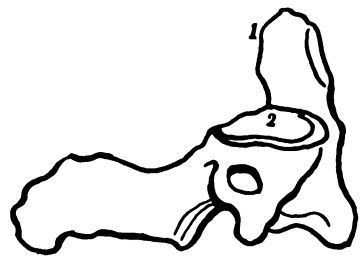
In the mechanical appendages, which we call arms and legs, different sorts of movable joints are employed. The ball-and-socket joint is one in which the rounded end of one bone fits into a cup-like hollow in another bone. The hinge-joint allows of motion only in one direction, like the hinge-joint of a door. A boy could not play baseball very well if he had a ball and-socket joint at elbows and knees, and a hinge-joint at hips and shoulders, so he will appreciate the fact that this condition is reversed, and that the joints which allow freedom of motion are placed at hip and shoulders, and the hinge-joints at elbows and knees.



The atlas, or the first vertebra, viewed from above; (1) the process of the axis; (2) the opening of the spinal cord; 3) the place on which the skull rests. The dotted line represents a ligament which holds the process, (1) in place.

The upper story, or head, is united to the spinal column by a pivot joint; that is, a projection of

one bone is surrounded by a ring of another bone, and that allows a turning and twisting motion.



The axis, or the second vertebra, viewed from the side: (1) the process on which the atlas turns; (2) the place on which the atlas rests.

I have not time to tell you about all of the admirable contrivances of the frame-work of this wonderful house, but I advise you to study it. Instead of thinking of the bony skeleton as a frightful thing, consider it a marvelous piece of machinery, wonderfully adapted to a designed purpose, and affording lessons in mechanism to the wisest builders and engineers.

Now perhaps you will say, "You told us that the frame-work of the body is made of bone, but what is bone made of?" The chemist tells us that bones are made of animal and earthy matter, and that we can prove this for ourselves if we wish. We can destroy the animal matter by burning the bone, and the earthy matter thus left will still keep the shape of the bone, but it will crumble to pieces at the slightest touch. If we put two ounces of

muriatic acid in one pint of water, and soak a bone in it for two or three days, the earthy matter will be dissolved, while the shape of the bone will be unchanged. It will be so flexible that we can tie it in a knot without breaking it. This might make it very pretty to look at, but such bones would not make a very solid frame-work for our bodily house, so it is quite important that we should learn how bones grow and whether there is anything we can do to make them strong. The bones of little children are mostly of animal matter so that they bend easily and are not so easily broken. The bones of older people break more readily because they have a much larger proportion of earthy matter. When we come to talk of the guests which man entertains in his bodily dwelling, we shall have something to say of how bones may be made strong and kept in good health.

The foundations of many buildings are made of stone and cemented with mortar, and mortar is made of lime. Bones are made strong by lime in various forms, so they are not unlike foundations after all. If we could look into the bones of a living child, we would see them changing from the soft, flexible bones of the baby to the strong, hard bones of the man by the accumulation, at various points, of little bits of lime, or calcareous matter. They are beginning to ossify, or *bonify*, if we may

make a word. These limey spots grow bigger and bigger until they unite in one hard bone. But, although the bones are hard, they are not solid. Even flat bones are made with little holes in their substance, which give them a kind of spongy appearance, and the shafts of the long bones are hollow.

The ends of the long bones are large and rounded to form the joints, and are tipped with cushions of cartilage, or gristle. They are held together by

bands called ligaments, and are enclosed in a sac having the power to make a fluid which, in a way, oils the joints. At railway stations you have often seen a man oiling the wheels of a train; or perhaps the train stopped between stations, and when people asked, "What is the matter?" the answer was "Hot-box." Looking out of the window, you have seen men pouring water on a smoking axle, and were told that the friction had been so great that smoke, or even fire, had resulted. And that was perhaps because some one had forgotten to oil that wheel. But the machinery of our bodily house oils itself, and that saves us a great deal of

anxiety for fear that we may forget some important part.

The frame-work is held together by the white, shining ligaments, which are tough and strong, but flexible. So now we have the frame-work jointed and tied together, but it hangs still and motionless.

DIAGRAM OF FRAME-WORK OF THE BODY.

CHAPTER III.

THE WALLS AND MACHINERY.

THE walls of the buildings at the great Columbian Exposition were covered with a material called staff. This is a composition of plaster of Paris which can be formed into many beautiful shapes, and will in time become hard and unchangeable. The walls enclosing the various apartments of our bodily dwellings are made of a substance called muscle, a material which permits the house to assume many shapes and change them often.

Instead of being injured by the constant variety of attitudes, the walls grow stronger the more they are used. Muscles not only form the walls, but they are also the machinery for moving the bony frame-work, so muscles cover the arms and legs as well as the trunk of the body.

I once went into a Swedish movement room where, making a great din, were many machines, the purpose of which was to exercise the various parts of the body, and people were going from one to another to be exercised. Here was a

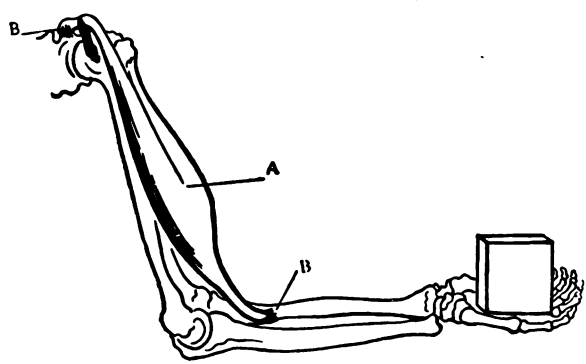
machine that shook the feet sidewise; another that vibrated them up and down; here, a machine that twisted the body; and here, one that lifted and dropped the shoulders. All the machines were running at the same rate of speed, and repeating the motion just so often without variation.

"This is very clever," I thought, and then I remembered our bodily dwelling, and said, "How much more is its mechanism to be admired! There is no noise, the movements vary in speed at any instant, as Man wills, and all are combined in one compact machine always at hand and ready for use, so that he does not have to go to one place to shake his hands and to another to shake his feet, and to still another to twist his body."

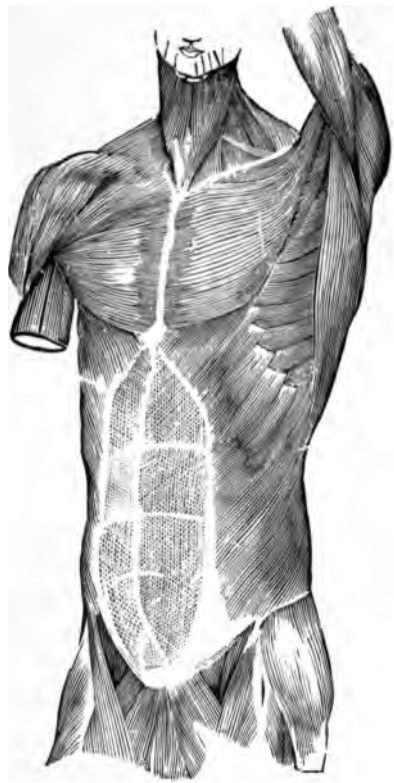
But what moves this muscular machinery? In the Swedish movement room we could see the whirling wheels and bands and we knew that in another room was an engine that transmitted power through shafts to them. But we cannot see such an arrangement in our muscles. This brings me to tell you of the wonderful properties of muscles. The first I shall name is contractility. When you want some one to know what strong muscles you have, you ask him to feel of your arm, and then you clinch your fist, and bend your elbow and say, "Can you feel it swell?"

It was the swelling of the muscles that made the

elbow bend. The muscles contracted and grew shorter and at the same time larger around. This is what is meant by contractility, and it is by this property of muscles that all movements are made. We have little idea of the force with which muscles contract, they move so easily, but we are told that with a ten-pound weight in the hand the muscles that bend the elbow contract with a force of two hundred pounds. It is also said that a muscle contracts better when it has a weight to lift than when it has none. Below is an illustration of the contractility of muscle.



The second property of muscles is irritability. That does not mean that they get cross if called on to work but it means that they respond to stimuli. A boy that is hopping about in a lively manner while being punished is responding to the



MUSCLES IN FRONT OF BODY.

stimulus of the whip. When he goes quietly to obey his father's orders, he is responding to the stimulus of a command.

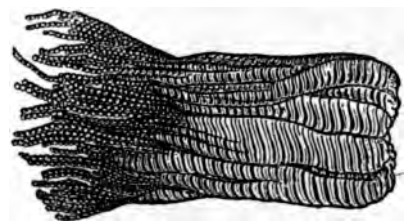
The usual stimulus of the muscles is will-power sent over the nerves. But muscles also respond to the stimulus of heat, or to pricking, or pinching, or to electricity.

Muscles have also the property of elasticity; that is, of going back to their original length after being stretched, as a piece of rubber does; and that is an important quality, you see, or it might be a serious matter to stretch our muscles, and we would be kept from doing many things we want to do for fear we could not get our muscles back again as they were. But our muscles are always slightly on the stretch. If it were not so we should be obliged to "take in slack," as it were, whenever we want to make a motion before the movement could begin; but because they are always slightly stretched, they can begin to contract as soon as the stimulus is felt.

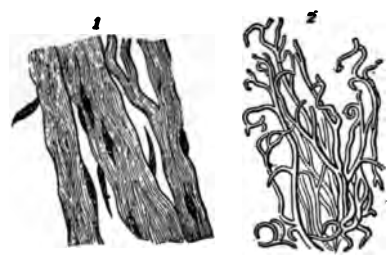
If muscles were used only as the walls of our house, they might be laid over the frame-work in flat masses, but as they are the motor power to lift and move the bony levers, they must be constructed and attached with that object in view.

Most muscles are made up of bundles of fleshy strings called fibers, and each fiber is made up of

very fine, small threads called fibrils. Each fiber is wrapped in a thin membrane, and a bundle of fibers wrapped in another membrane makes a



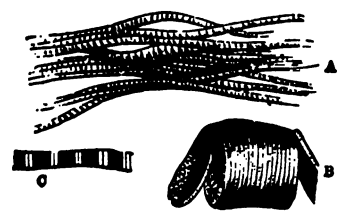
muscle. Fibrils are finer than cobweb, so fine, indeed, that it would need many thousands of them to make a bundle an inch thick. You will better understand how muscles are made, perhaps, if you examine a spool of cotton. You might think the



Fibers of (1) White Fibrous, and (2) Yellow Elastic Tissue.

thread all of one piece, but by twisting it toward you, you will discover three strands; each of these can be separated into still finer strands, and each of

these into finer ones still. These last represent the fibrils. There is one difference, however, between fibers of thread and those of muscle. In thread the fibers are twisted together; in muscles they



MUSCULAR FIBER SEPARATED.
A into fibers and B into discs. C is a highly magnified portion of a fiber.

lie side by side and are held together by a fine network of connective tissue; fat is packed around to fill all the spaces and form cushions to round out the body and make it look plump. Each muscle has a thick middle part and tapers at the ends into a strong white cord or band, called a tendon, and these tendons are fastened to the bones. There are more than twice as many muscles as bones; that is, nearly five hundred, and they work in pairs that oppose each other. It is not always "a long pull and a strong pull and a pull all together" with the muscles, but it is more like a "you pull against me and I'll pull against you, and between us we'll keep things straight." So when the work of one muscle is to bend any part of the body,

there will always be found an opposing muscle to straighten it. Those which bend are flexors. Those which straighten are extensors.

Think what a complicated machine this body is. Why, it takes six little muscles to turn the eyeballs in various directions, and there are about fifty in the arm and hand. These muscles under the microscope show a striped appearance and are called striated or striped muscles. Others, found chiefly in hollow organs, as the stomach, intestines, and blood vessels, do not appear striped and are therefore called non-striated or unstriped muscles.

Muscles are of different shapes. Some round, some flat, some long, others short, some very large, and some very small, and all have names. Sometimes the names are bigger and longer than the muscles themselves. For instance, the one that lifts the upper lip and expands the nostrils is called the *Levator Labii Superioris Alaeque Nasi.* Just think what a trouble it would be to call it by name every time you want it to work. Or imagine that you could never frown unless you called on the *Corrugator Supercilli* to pucker your forehead for you. It is a good thing for us that we can learn to manage our bodily machinery without knowing anything about the Latin names of the various parts, and the boy enjoys climbing trees even if he

knows nothing about the *Latissimus Dorsi* that pulls his arms back and enables him to climb.

Walking through the streets of a Southern city, my attention was attracted by a row of dilapidated tenement houses. The roof of one house sank in the middle until it made me think of a "sway-back" horse. One house had leaned over to one side until it seemed that it must certainly fall, and two had settled backward so that they looked as if they were tired, and were just going to sit down.

They were picturesque, but no one would earnestly desire to live in them, and to my eye a body that caves in at the thorax, and curves out at the shoulders, and whose neck is a veritable leaning tower with the cupola balanced at a precarious angle, is not to be admired, but most certainly to be avoided.

The erect attitude of the body maintains a vertical line from the center of the head down through the shoulders and hips to the ground. If the line between the shoulders and hips is in any degree oblique, the body is not balanced on the balls of the feet as it ought to be, but rests too much on the heels. If we closely observe people in our streets, we shall see that the majority carry the shoulders back of the hips. This throws the body out of balance, and as a consequence the head is projected forward, the back is rounded, the

chest is compressed, the abdomen made prominent, and the beautiful curves of the spine entirely changed. This attitude is not only unhealthful but ungraceful, and effectually prevents a dignified carriage and gait.

The habit of stooping is often acquired in schools, and parents, seeing the shoulders becoming rounded, keep up a continual cry of, "Draw your shoulders back"; and in the attempt to obey this order, the vertical line before mentioned becomes an oblique line and the ungainliness of attitude is emphasized rather than overcome.

To prevent or to cure round shoulders we have only to remember that the cause is not in the shoulders but in the disuse of those muscles which should hold up the front of the body. The military attitude accomplishes the desired result. The orders are to elevate the chest, draw in the chin, draw back the abdomen, and let the arms hang naturally. To follow this rule is at once to overcome the round shoulders.

If, instead of continually blaming the shoulders and trying to correct them, we should give our thought and attention to the strengthening of the muscles of the trunk of the body, especially the front-waist muscles, we would have adopted the most effectual means of procuring an erect and graceful attitude. Holding the chest well up is

very important, and by a very simple method we can be sure that we accomplish this.

Stand with the face to a blank wall, the toes touching; now bring the chest to the wall, keeping the abdomen back so that there will be a space between it and the wall. This is about the correct position. At first we may feel as if we were falling forward, but a glance into a mirror, as we stand sidewise before it, will show us that our attitude is merely an erect one, and this glance also will prove to us that this position adds greatly to the beauty and dignity of the person. More than that, it adds to the health, because the body being perfectly balanced, all its internal organs are rightly related to each other; they have room to work harmoniously, and the result will be manifest, not only in increased beauty of outline, but in a better digestion, a brighter eye, a more glowing cheek, and a clearer mind.

Description of Accompanying Cuts.[1]

Fig. 1. This is a good standing position but if maintained any length of time is wearisome, as it keeps both legs in a state of muscular activity, whereas they should work alternately.

Fig. 2. Position in walking. Also good rest position as it can be maintained some time without fatigue.

Fig. 3. Gives a broad base and is therefore often assumed. It is not desirable, as it produces slight curvature of the spine, and makes the body unsymmetrical.

Fig. 4. Good sitting position. Should become habitual.

Fig. 5. A very bad attitude as it twists the spine.

Fig. 6. An improper position pushing the shoulders up.

Fig. 7. An improper attitude, as it makes the left side shorter than the right.

Fig. 8. Very bad position, cramping the chest, crowding the contents of the abdomen downward.

Fig. 9. Very bad attitude, strains the spine, and tends to produce permanent curvature.

[1] These cuts are from the *Educational Review*, by permission of Holt & Company and of Dr. Eliza Mosher.

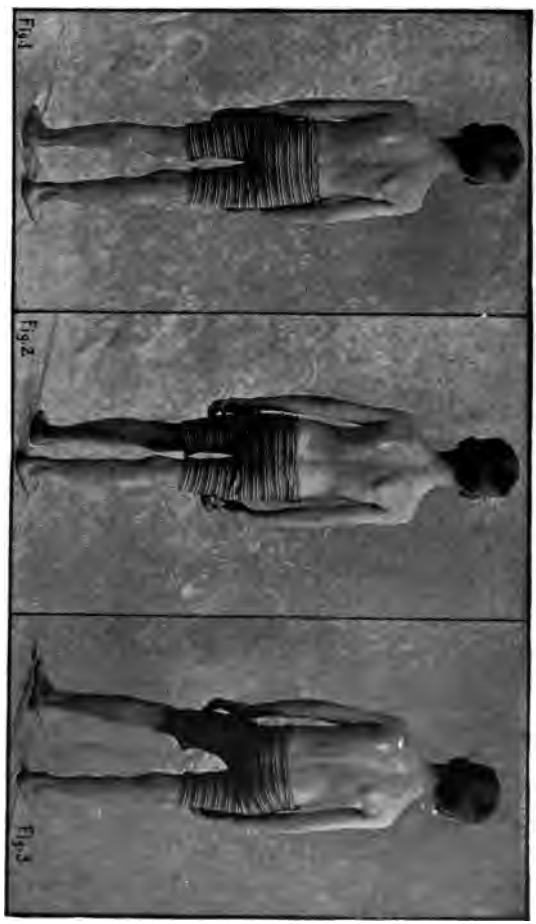


Fig.1
Fig.2
Fig.3

Fig. 4
Fig. 5
Fig. 6

Fig 7
Fig 8
Fig 9

CHAPTER IV.

THE SHEATHING.

ACROSS the street I see men covering the frame of a new house. They first put on a layer of rough boards; over these, a layer of felt paper, then narrow boards, the lower edges of which overlap the boards beneath. This makes a tight, warm, water-proof protection to the rooms inside. Our bodily house must also have a protecting covering; but if it were nailed on, all the elaborate machinery made to move it about would be of no use. Just imagine how it would be if we were afraid of breaking to pieces if we ran about, or of pulling out the nails that fastened our sidings on if we wanted to jump or climb!

The sheathing of our wonderful house is the skin, and the outer layer is formed of overlapping pieces more like scales or shingles than siding. This is called the epidermis, or scarf-skin. Beneath this is the dermis, or true skin, which is made of both muscular and elastic fibers filled in with fat. The dermis is the part through which run the plumbing tubes spoken of in the last

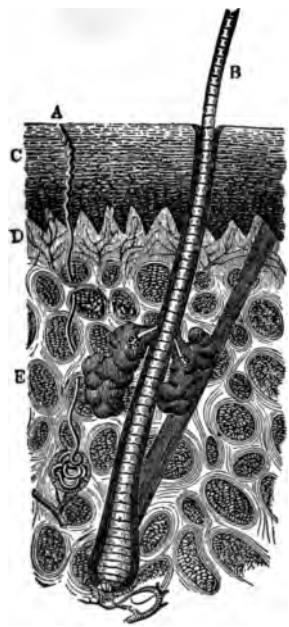
chapter, and in it also are the ends of the electric wires or nerves that carry messages from the central office to all parts of the house.

In the building which the carpenters are covering with boards, the rough ones are put underneath and the smooth ones outside, and then a coat of paint is put on to give it a beautiful color. One peculiarity of the work of the divine Architect is the more closely and deeply we examine it, the more beautiful we discover it to be. The outer covering is the coarse one, made as it is of horny scales that grow harder and harder as they are used, until, in places like the palm of the laborer's hand, they form what we call a callous. Under this coarse outside covering is the beautiful true skin, blushing with the bright color of the blood with which it is so richly supplied. The divine Architect does not paint the bodily house on the outside, but in the lower layer of the upper skin is deposited a pigment which gives the house its hue. Some houses are a beautiful pink and white; in them there is little of the pigment or coloring matter. Others are yellow, others deep brown, and some are quite black; but, if the outer skin be removed, the true skin will be found to be just alike in all.

The office of the skin is to protect the body; to keep it warm; to regulate the temperature; to carry the plumbing tubes of the blood vessels and

sweat glands, and the electric wires of the nerves; and to hold the oil glands that keep it soft and smooth.

SECTION OF SKIN.



A. Sweat gland. *B* Hair in its follicle.
C. Epidermis. *D* Dermis.
E. Sebaceous. *M*. Muscle.

CHAPTER V.

THE PLUMBING.

A VERY important part of every modern house is the plumbing. Water pipes, gas pipes, drainage pipes, electric wires, and speaking tubes run in the walls, and between the floors, and the health and comfort of the household depend upon the perfection of the plumber's work. Knowing that the divine Architect is all-wise, we would naturally expect the plumbing of our bodily dwelling to be perfect, and we are not disappointed. That is, it is created perfect, but we often let it get out of repair, and then we suffer. Perhaps we blame the Architect for this when we ourselves are at fault.

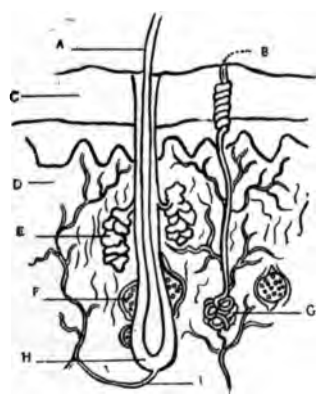
Minute tubes, called blood vessels, some conveying fluid nourishment and others carrying away waste material, pass through the muscular walls and even through the solid substance of the bones. The muscles are covered by a sheathing called the skin which is full of tubes, so full that you cannot put down the point of a pin anywhere upon it without opening many of them and drawing blood. In the skin is also a system of drainage pipes

called sweat glands. (See illustration on page 47.) They are very fine tubes, so short that ten of them, end to end, would only make an inch in length, and yet there are so many of them in the body all coiled up into knots, that if they were straightened out and laid end to end they would reach over four miles. There is something for you to think about.

In this chapter we learn only of the drainage pipes which are located in the skin, while the tubes that carry fluids to all parts of the body and those which act as drainage pipes to carry off waste matter from the interior will be described in the various rooms to which they belong.

If a drop of water falls on a hot stove, it dries so quickly that we see no steam, but if we pour on a large quantity at once we see the vapor and know that the water is evaporated. When you run and get very warm, the sweat glands pour out water on the skin in large drops which are called perspiration. These glands are not idle even while we do not see the water on the surface of the body. They are at work all the time, but the water usually evaporates as soon as it reaches the surface. This we call insensible perspiration. It is all the time passing from the skin, and we are told that it amounts to nearly two pounds in twenty-four hours. When we exercise, it is greatly increased and may amount to one pound in one

hour. This waste of water on the surface of the body must be replaced by the water we drink, and that explains why we are so thirsty in hot weather or when we exercise. Heat causes these glands to throw out water rapidly, and the evaporation of the water carries off the heat of the body and keeps the temperature down to the normal point. If for any reason we cannot perspire in hot weather, or when we exercise, we suffer greatly.



VERTICAL SECTION OF THE SKIN.

A' Hair; B, Sweat pore; C, Epidermis, or outer layer of skin; D, Dermis, or inner layer of skin; E, Oil glands; F, Fat Cells; G, Sweat gland; H, Hair bulb; I. Blood tube.

The perspiration is something besides water; it contains solid waste material, which, as the water evaporates, is left on the skin and stops up the little drainage tubes, unless we keep them open by

frequent bathing. The little oil glands in the skin pour out a fatty secretion that dries on the surface, and the skin itself sheds little pieces of worn-out substance, which are caught in the perspiration as it dries, and cling to the surface. If we want the drainage of our bodily house to be faultless, we must keep these tubes open by the frequent use of soap and warm water.

A few practical suggestions as to taking care of the skin so that its water-pipes may be kept in working order will not be amiss.

Rules for Bathing.

1. Never bathe sooner than two hours after a meal. To draw the blood to the surface of the body soon after eating interferes with digestion. Going in swimming soon after eating is especially dangerous, and a post-mortem examination of those who have lost their lives in this way reveals the fact that the pressure of the water forces the contents of the full stomach up into the esophagus and throat, and from there they are drawn into the trachea, causing suffocation. On the other hand, one should not eat under an hour after bathing.

2. Feeble persons should rest after bathing until the equilibrium of the circulation is restored. Those who are vigorous may exercise after a bath.

3. Never bathe when completely exhausted. A bath, to be beneficial, must be followed by complete reaction, or sensation of warmth, and this is not possible when a person is fatigued.

4. The temperature of the bath-room is of importance, for, if too cold, it will require too much vitality to react. If the bath leaves the skin blue and cold, and the person shivers and cannot get warm for some hours, it has been an injury.

5. The hot bath should be followed by a quick application of cold water, so as to leave the skin in a tonic condition, thus lessening the danger of taking cold.

The time of day best suited for an individual to bathe must be decided by his peculiarities, or by the circumstances of his life. Perhaps, theoretically, ten or eleven o'clock in the morning is the best time, but, practically, this is, for most people, a very inconvenient hour. Delicate people, perhaps, would do best to bathe just before going to bed. Vigorous people might bathe on rising in the morning. Rubbing with olive oil or cocoa butter after the bath keeps the skin smooth and supple, and acts also as a sort of covering to prevent taking cold.

Dry rubbing of the skin may also be employed in place of the bath. It will remove the dead scales of the scarf skin and keep the pores open.

CHAPTER VI.

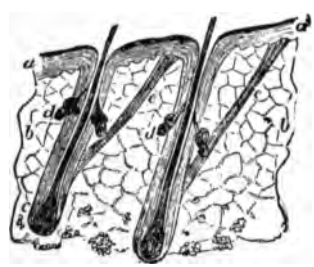
THE THATCH.

IN the old world, houses are often thatched with straw instead of being roofed with shingles, slate, or tin, and we may say that our house has a thatch, not of straw, but of hair. Little new houses have not much thatch, and in old houses the thatch is sometimes worn off, and then we say they are bald. Hairs grow from little pockets in the skin; and, in fact, they are a continuation of the cells of the skin itself, carrying with them the same pigment that gives the skin its color. So we find that dark people have dark hair, and fair people have yellow or red hair. When no coloring matter is furnished, the hair becomes gray or even white. Into each hair pocket or follicle a little oil gland opens, so, you see, each separate hair has its own bottle of hair oil. If we keep the head clean and brush the hair well, we shall have no need of putting oil on it to keep it smooth.

Each hair has a muscle; it has also a nerve, and that is why it hurts when the hair is pulled. Cold air, or water, or a sudden fright will make these muscles contract, and this is what makes the

hair stand on end, as we say. That is illustrated when a cat sees a dog and bristles up all over. One of Job's friends says that he was frightened and his hair stood up. Read Job, 4th chapter, 15th verse.

Hair is very elastic, and will stretch a good deal before breaking. It is also very strong. A single hair has held a weight of two and a half ounces. Hair is found all over the body except on the palms of the hands and the soles of the feet.

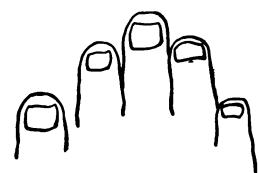


HAIR, HAIR FOLLICLES AND GLANDS.
A, epidermis; *B*, true skin; *C*, hair bulbs; *D*, glands; *E*, muscle attached to hair sac.

The cells of the skin become hardened and form the nails, which protect the fingers and toes. If it were not for the finger-nails, we would find it difficult to untie knots, open pocket knives, and do many things we now do with ease. When we care for them, they also add to the beauty of the hand; but if not trimmed neatly and kept clean, they are indicative of a lack of careful training.

A young girl was once putting on airs and attempting to pass herself off for a person of great importance, but another girl, who had been well brought up and trained to exquisite care of herself, recognized the lack of this, and exclaimed, "She's not a lady, look at her finger-nails!"

WELL-KEPT NAILS.



NEGLECTED NAILS.

HEAD OF APOLLO BELVIDERE.

CHAPTER VII.

THE UPPER STORY, OR CUPOLA.

ON a short tower, called the neck, is found the most wonderful part of the house, the cupola, or head. It has a solid, dome-like, bony framework, covered with muscular walls, protected by the skin, and roofed with the hairy thatch. In its façade we have two windows — only two for the whole house, and yet they command a view in all directions because the cupola is so balanced that

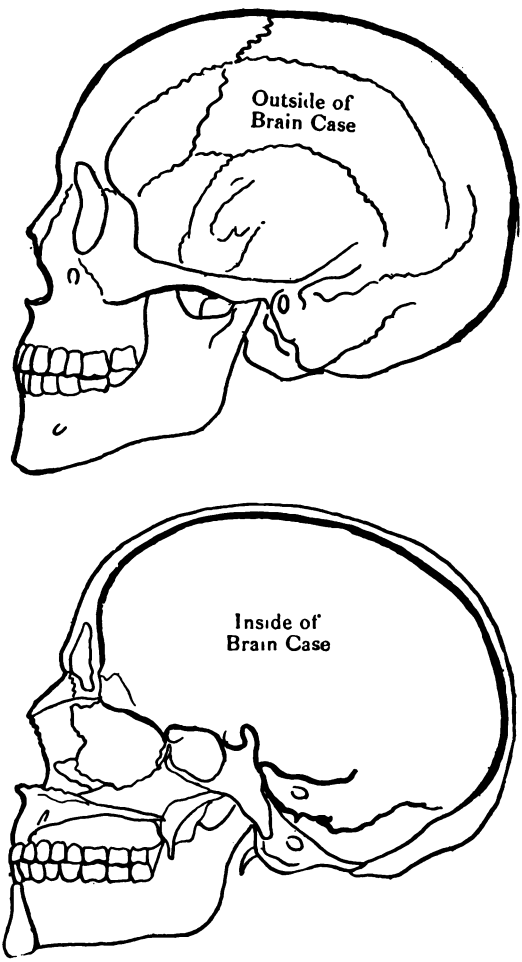
it can turn from side to side, or up, or down, and if we have need to look behind us, we have only to turn the whole house around. I once read of a man who built his house on the abandoned turn-table of a railroad, and when he wanted the sun to shine in any apartment, he had only to turn the house around. He thought that was a very fine contrivance, but, you see, that is what we all can do with our wonderful house, and we do it so often that we think nothing of it.

Over the window is a little thatch of hair to keep the rain of perspiration from running down into the eyes. Between the windows is a portico with two circular doorways, through which the good fairy Aura goes in and out. Below these is a pair of pink folding doors about which I shall have more to tell you. On the sides of the cupola are porticos for the admission of sound. How seldom we think of the fact that Man knows nothing of the world except through the medium of his bodily house. If his windows are broken, he sees no more; if his porticos of sound are stopped up, he can hear nothing; and yet, knowing this, he sometimes takes very little pains to keep his house in order. He will read by twilight, or on the cars, or strain his eyes needlessly just as if he were certain that he could go out and buy a new pair when these were gone. What we want to do is to

learn about our bodily dwelling, so that we may know how to keep it in repair; therefore we will go on to study our upper story, the general office of the establishment.

DIAGRAM OF SPINE.

The contents of this upper story are so important and valuable that they must be well protected, and so the frame-work is very strong and solid, made of twenty-two bones, dovetailed together in a spherical form, as that is the strongest possible shape. Eight of these bones, each made of three layers, form what is called the cranium, or brain case. The outside layer is thick, tough, and somewhat elastic, so that quite hard blows do not break it. The inner layer is thin, hard, and brittle, so it is called the vitreous, or glassy table of the skull. This might break easily, but between it and the outer layer is a spongy tissue of bone


Outside of
Brain Case
Inside of
Brain Case

which deadens blows. See how wonderfully all this is arranged to protect the brain. First, the arched or spherical shape made of several pieces, and then the three layers of bone with their elastic and spongy construction, and these mounted on the springy, flexible spinal column, all tending, as you see, to save the brain from jars, and make it safe for us to jump and climb and even receive falls and blows without serious injury.

We adorn the inner walls of our residences with beautiful paper, or paint them various tints. The inner walls of the cupola is covered with three membranes; the one lying close to the inside of the skull is dense and fibrous, and is called the *dura mater*, the hard or durable mother. Inside of this is a very fine membrane called the *arachnoid*. There is a fable which tells of the Princess Arachne who was famed for spinning and was changed by Minerva into a spider. This membrane is called the arachnoid because it is like the cobweb for delicacy. The inner membrane is also fine and delicate and full of blood vessels. It is called the *pia mater*, or soft mother. And what shall we find in this room so carefully prepared? Something wonderful and very precious no doubt.

CHAPTER VIII.

THE GENERAL OFFICE.

THE apartment whose walls were described in the last chapter is called the cavity of the skull, and is occupied by a wonderful workshop known as the brain.

Michelet, a French writer, calls it the "flower of flowers." That is very pretty, but, after all, does not give us much idea how it appears. If you could see the brain of a calf, it would give you a very good idea of the brain of man. The meat of an English walnut, in its folds and wrinkles, is something like the brain in shape but not in size. A large piece of paper can be crumpled into a small space; and if the wrinkles of the brain-substance were spread out like a plain piece of paper, we should see that these folds have really given it a very large surface. The average weight of the human brain is from 45 to 55 ounces. The brain of man is absolutely larger than the brain of any animal except that of the whale and the elephant.

The brain is composed of two kinds of matter;

one white, which forms the greater part of the interior, and the other gray, which spreads over the surface and dips down into all the folds, or convolutions, as they are called. The depth of the convolutions seems to measure the intelligence of the individual. In a baby's brain the convolutions are very shallow, but as he becomes more and

VIEW OF UPPER SURFACE OF THE BRAIN.

more intelligent, they grow deeper, so you see that skulls of the same size may both be full of brains, and yet one contain a great deal more brain than the other, because it is more deeply wrinkled or convoluted. You must not be discouraged by the big words we have to use in the

study of the brain, or get tired and say you don't care to learn about it, because it is so uninteresting. Many things which, in the beginning may seem very dry, become very interesting to us after we have learned about them; and perhaps in the study of the brain we shall put added wrinkles into our own brain-substance and be so much the brighter.

The brain is divided into the *cerebrum*, or great brain, and the *cerebellum*, or little brain, and the *Medulla oblongata*, or hind brain, and each has its special work to do. We shall find very much to interest us in the different kinds of work that are done in the different parts of the brain. The great brain occupies the upper and front part of the cavity of the skull, and the small brain, the lower and back part. The two brains are connected by a bridge called the *Pons Varolii* because a man named Varolius first described it. Did you ever imagine that you had a bridge in your head?

Brain looks not unlike a mass of dough in color, but is more like jelly in consistency. It is made of millions of little cells about which we shall learn when we study the servants of our wonderful house.

CHAPTER IX.

THE RECEPTION ROOM AND HALL.

BETWEEN the windows of our house is a porch with a sloping roof that covers two circular doorways. Below this is a pair of pink folding doors that open into the reception room. These doors are beautiful and have marvelous capabilities. They are closed by a muscle called a sphincter, which acts much like the puckering strings of our shopping bags. When drawn up tight, the doors are pulled into folds, and in this shape can make very pretty music called whistling. When stretched, they produce what is known as a smile; or if the stretching is extreme, and we hear a loud "Ha! ha!" issuing from the doorway, we say that the man is laughing. That is the way Man has of letting it be known that he is greatly pleased. These doors also help him to make known his wishes, thoughts, and feelings, by means of spoken words, and these may be very pleasant or quite the contrary. We might almost call these doors curtains, for they are of soft muscle and have a bright pink lining of mucous membrane.

In some individuals, an ornamental lambrequin of hair is fastened above these doors. It is not only an ornament but acts as a guard to the circular doorways above.

We may as well learn right here that all the apartments of our bodily dwelling communicating with the outer world are lined with mucous membrane, which in its structure is not unlike the skin, and is united with it at the openings into these rooms. At the edges of the lips we can see where this union takes place. The purpose of this membrane is to secrete a fluid which moistens the surface.

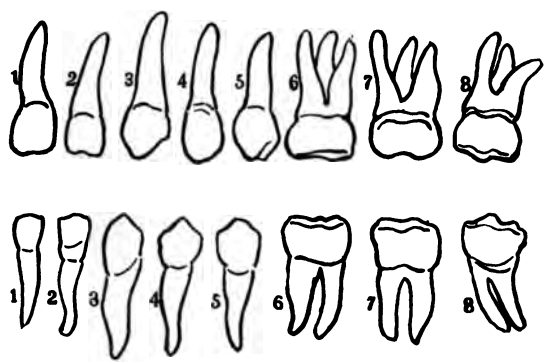
When the hands bring to the mouth any guests who desire to enter the house, the lips open to take them in, and, passing their folds, the guests are received by thirty-two attendants in a white uniform whose business it is to remove the wraps of visitors and make them fine enough to go on and visit the cook; for all who enter here are on their way to the kitchen. I said there were thirty-two attendants in white. There are not always thirty-two, and they are not always in white. Sometimes their uniforms have been sadly soiled and torn, and have been patched and the patching trimmed with gold, which does not add to their beauty, however.

In little new houses these attendants are alto-

gether invisible, but they are only asleep in their little pink cradles in the frame of the doorways called the jaws. There are only twenty of these, however, and for some months they lie still and sleep. Then they begin to be anxious to see the world and push their heads up so hard that they often make the baby cry. But they don't seem to care for that, for they push away until one by one their little white crowns appear. Did I not tell you that they were royal attendants? Oh yes, they are, for each one wears a crown. For six or seven years these little servants stay, and then are crowded out by others who have lain in their cradles all this while, only waiting for the time to come for them to crowd their older brothers entirely out of the way and take their places, and now there are thirty-two of them, sixteen in each jaw.

In the center of each jaw are four sharp fellows called incisors, who investigate every visitor in a biting way, and pass him on to the rest, and they press him on all sides until, when they are through with him, he feels pretty well crushed. One long sharp fellow on each side of the incisors is known as a cuspid. Next to each cuspid stand two who are called bi-cuspids because they wear two cusps or crowns, and back of these stand three molars or grinders. You are acquainted with all these attendants as the teeth.

Sometimes visitors on their way to the kitchen are so soft that they slip through without much attention from the molars, but they are really not as well received by the cook as if they had been willing to be more thoroughly investigated. Then, too, it is no kindness to be sparing of the work of



ADULT TEETH.
1, 2. The Cutting Teeth (incisors). 3, Canine. 4, 5, Small Grinders (biscuspids) 6, 7, 8, Grinders (molars).

the molars, for they keep stronger and last longer if they have plenty of hard work to do. That is one peculiarity of our house. All of its workers keep in better health if they have plenty of the right kind of work to do.

I might suggest to you that these thirty-two servants, the teeth, need frequent bathing and scrubbing with a soft brush, if you want them to keep in good health. When they are through

with their work, they should have all dirt carefully removed, not only from the surface but from between them. They are such sturdy soldiers that they never break ranks, so you will have to clean them as they stand solidly and closely together; and I would warn you to use them well and not to bite thread, crack nuts, or pull needles or nails with them (I have known people to do that), for this may injure their constitutions so that they break down altogether, and then you will be in a sad plight, indeed.

These attendants do not do their full work until visitors have been judged by a guard in a pink sentry box, who occupies a constant position in the reception room for the purpose of passing his opinion on guests. This sentry box is chained to the floor so that the guard never can go away from home. The name of this guard is Gustatory Sense, or Taste, as he is sometimes called for short. If those who enter here are pleasing to him, he allows them to receive the attention of the teeth; if not, he rejects them at once. However, he is not to be fully relied upon, for he sometimes becomes very fond of those who are injurious to the best interests of the house, and allows their entrance when he ought to put them out immediately. In this case he consults his own whims and fancies rather than the welfare of the house and its master.

Certain persons have the power of making every one feel at ease, and we find some such affable attendants in the reception room of our house. There are three closets called glands on each side of the reception room, making six in all, and from these issues Saliva, whose especial business it is to help guests along. Some folks, you know, are so stiff in their manners that we say they are "starched up," and Saliva pays especial attention to such, accompanying them all the way to the kitchen, and

THE PAROTID — ONE OF THE SALIVARY GLANDS.

making them very sweet by changing their starch into sugar.

The roof of the reception room is arched or vaulted, and is called the hard palate. At the back of this room, which you know as the mouth, are two fleshy pillars, and between these is hung a

pink portiere, or curtain, composed of the uvula and soft palate. This curtain answers a double purpose; it divides the reception room from the hall, and it is also drawn up and back to close the passage into the nose when solids or liquids are passing down the throat.

We shall now talk of the throat as the hall of our wonderful house. It is a peculiar hall in that it has no floor. Seven passages lead out of it; one into the mouth, two up into the nose, two into the ears, one to the lungs, and one to the stomach. We shall study each of these by and by. Now we will go with the guests across the hall, or pharynx, to the kitchen stairs, or esophagus, as it is called. These are peculiar stairs, about nine inches long, not quite straight, and with muscular walls which contract behind the descending substance and push it along. If it is a very small substance, these muscles have very hard work to squeeze it down, and that is why we may find it so difficult to swallow a small pill when we can easily swallow a mouthful of food.

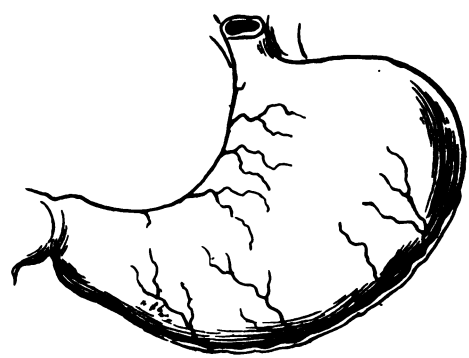
CHAPTER X.

THE KITCHEN.

AT the bottom of the stairs we find ourselves at the top of the kitchen, and must jump down the rest of the way. This kitchen is a wonderful room, and when full is about one foot long and four inches broad. If you have ever studied in the kindergarten, I suppose you would call it irregularly conical in shape. This room, which is named stomach, has a strong wall of three coats, the outer one of fibrous tissue, called the serous coat, the inner, a mucous membrane, and between these a muscular coat whose fibers run in three directions — one set lengthwise, one around, and one obliquely. When these three sets of muscles contract, you can understand how they draw the stomach into a smaller compass and so churn the contents about. Here in this active, moving kitchen we find the cook, Gastric Juice, at work, cutting up the meat, peeling the vegetables, and breaking them into small pieces. He pays no attention to starch, but the saliva that accompanied starch into the stomach still acts upon it.

Oil is churned by the motion of the stomach, and so all the contents are thoroughly mingled.

In the walls of the kitchen are little depressions which we may call cupboards, where Gastric Juice finds the substances he needs in his work. As the material for the nourishment and repair of the house is prepared in this room, it is quite important that we should understand its laws, for every



THE STOMACH.

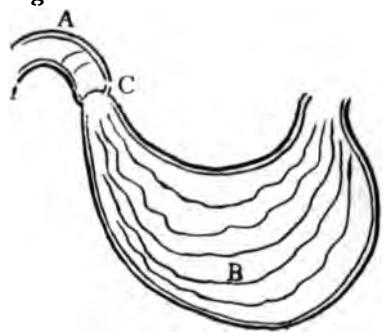
part of our house is governed by laws which were laid down by the divine Architect himself. One of these laws is that food to be digested must be at blood heat. It is therefore injurious to drink large quantities of very cold water while we are eating; for, as we can easily see, it puts out the kitchen fire, and so hinders the cook in his work.

Ice water, too, by suddenly checking perspiration and chilling the body when heated, has caused death.

We can interfere with the work of the stomach by eating too much, for when the walls are greatly distended they cannot easily contract, and so stomach digestion is hindered. From three to five hours are needed to complete the work of the stomach, and to eat between meals gives the cook extra labor, and then, perhaps, he does nothing well. You can imagine how cross you would be if you had a cake half baked, and some one should open the oven door and stir into it a quantity of raw material, even if it were the same as that of which the cake was made, and more angry still if it were raw apples or nuts or candy. You ought, therefore, to be as thoughtful of your bodily cook as you would like others to be if you were cooking.

The exit from the kitchen is through an opening called the *pylorus*, which only allows food to pass out when thoroughly churned and mixed with the active substances of the Gastric Juice. This gate sometimes refuses to let things pass at all, in which case they may be sent hurriedly back up the stairs, through the hall and reception room, and cast out of the front door. This we call vomiting. It occurs when poisonous or hurtful materials are swallowed, or when the work of the cook has been

for some time greatly interfered with by overeating, or by eating unwholesome food.



A, Duodenum; *B*, Stomach; *C*, Pylorus.

Chemistry takes food to pieces and tells us that it is made of carbon, hydrogen, nitrogen, and oxygen. Man's body is made of the same elements, but we cannot live on them in that form; we must have them made up into various combinations. Plants can take them in the raw state and make them over into themselves, then we get them from the plants; or other animals eat the plants and then we eat the animals. Some substances contain all these elements and are called proteids or, sometimes, albuminoids, because they are like albumen, or white of egg. Another substance containing all the elements is called gluten, and is found in grains. Still another is called legumin, found in peas and beans. Casein is found in milk, and myosin, in muscle.

To obtain the right amount needed to keep the body in repair, we do not try to find some one substance containing all the elements, but we eat a variety of foods, such as bread, meat, eggs, milk, grains, and fruits, so that the servants and general manager can select from the whole mass the things that are needed. We should not try to live wholly on starch and sweets which alone will not keep us alive.

All the foods we eat may be divided into nitrogenous, oleaginous or fatty, saccharine or that containing sugar, and amylaceous or starchy. We have seen that saliva digests starch, and that gastric juice acts on all nitrogenous substances; but as yet we have found nothing that acts on fats. These oily guests come into our house and slip down into the kitchen where no notice is taken of them except to make them step around rather lively, until they come to have a much smaller opinion of themselves than when they entered, and then they are allowed, with all the rest to pass through the pylorus into the next apartment.

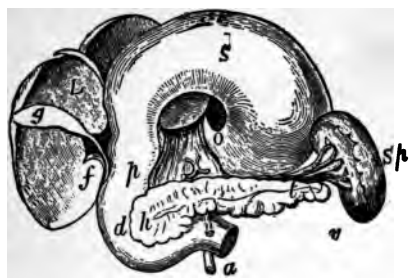
Water is also a very important food, both because the body is about three-fourths water, and because water is being cast off constantly through the drainage tubes and must be replaced As fruits are largely composed of water, they are valuable both as food and drink.

CHAPTER XI.

THE BUTLER'S PANTRY.

THE next room is sometimes called the second kitchen, but it has also a Latin name, *duodenum*, because it is as long as twelve fingers are broad. It is very narrow and curved like a horseshoe, and its walls, like those of the stomach, are serous, muscular, and mucous. The food that has been broken up in the kitchen passes into the butler's pantry ready to be further prepared for use, and here come two important assistants to help do the work. They are called Pancreatic Juice and Bile. Pancreatic Juice is said to be the most important helper in the preparation of foods for use in the house, though, like many other important people, he is seldom mentioned, and many have never heard of him. He is of a kindly nature and does not ask whether those who need his aid are rich or poor, but gives attention to all. He completes the work which Saliva began on the starch, and finishes on the nitrogenous materials, sometimes called albuminoids, what Gastric Juice has left undone. He also acts on the oily

substances,— splits them up, as it is said. Pancreatic Juice has his home in a room called the pancreas. In animals it is called the sweet-bread.



PANCREAS AND SPLEEN.

The stomach is represented as turned up, *S* being on its under surface. *P* indicates the junction of the stomach and duodenum *d* at the pylorus. *O* is placed at the junction of stomach and gullet. *L* is on the right portion of the liver, which is also turned up to show *g*, the gall bladder *f* is placed to the side of the common bile-duct formed by ducts from the liver and gall bladder. *h-t* is the pancreas, revealed by the turning up of the stomach *Sp*, spleen. *v*, the part where blood-vessels are connected to the spleen. *a* and *a*, blood-vessels.

Bile comes from the liver, and after leaving his own especial room, the gall-bladder, he passes down a hall, known as the common bile-duct, into the butler's pantry, where he joins in the work of preparing the food for use. It used to be thought that Bile was aristocratic, and that he only paid attention to those who had "struck oil," in other words, the fats, but we find now that he condescends to do other work. Indeed, we are told

that he does not attend to fats perfectly without the aid of Pancreatic Juice. One of the offices of Bile is to prevent things from getting into that disturbed state known as putrefactive fermentation; that is, to keep them sweet and good. He also assists greatly in the taking up of the nutritious material by the little eaters of the dining-room, known as absorbents, and he is also willing to help do the work of sweeping out the dining-room. So I think that we ought not to say that Bile is aristocratic, but should give him credit for all he does so willingly.

The walls of the Butler's Pantry are fitted up with shelves made of folds of the mucous membrane, and this, you see, increases the surface. There are also many little cupboards, called glands, which secrete a fluid to be used in the work of digestion.

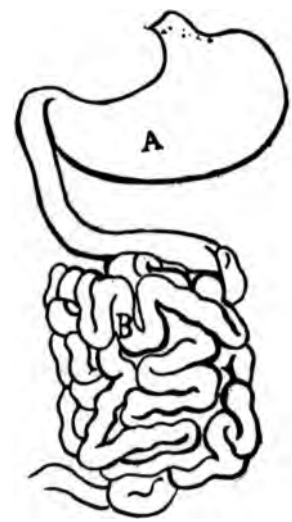
CHAPTER XII.

THE DINING-ROOM.

OPENING out of the butler's pantry is the dining-room, a long, narrow apartment about an inch across but more than twenty feet in length, It has the same three muscular coats as the kitchen and butler's pantry. The first eight feet receives the name of the *jejunum*, a Latin word meaning empty, because it is usually found empty after death. The remainder is called the *ilium*, meaning twisted.

This long, narrow dining-room occupies the greater part of the second story of the house — the abdominal cavity; and, as this is comparatively a small place, the intestines must be folded and coiled to fit into it. They are not just twisted up and laid loosely in the abdominal cavity, but are held in place by a membrane called the mesentery. This membrane is as long as the intestines, but only about four inches broad. The intestines lie along one edge like the trimming on a ruffle, and the other edge is gathered, like a ruffle, into a length of six inches, and this fastened to the spine,

thus holding the intestines in place and yet leaving them somewhat free. The internal lining of intestines is in folds, making the same shelves as are found in the pantry, and for the same purpose of increasing the surface. Here, also, are



A, Stomach. *B*, Small Intestines.

glands secreting the fluids needed to complete the work of digestion. The head waiter is Pancreatic Juice but he has a valuable assistant named Intestinal Juice and they together complete all processes of digestion and the preparation of food for absorption.

And who is to eat the dinner so elaborately prepared? Oh, the dining-room is always full of hungry little mouths ready to take in the food. They are never away riding a "safety" or playing lawn tennis; they never wait for the dinner bell to ring and then go scampering in with hair awry; they are always right there attending strictly to the business of eating. And such quiet, polite little eaters as they are. They never crowd each other nor scramble for the food, nor refuse to eat good bread and butter because they want cake. They are so small that as many as sixty of them are found in the one-hundredth part of a square inch.

VILLI.

When we were on shipboard, we found our chairs were fastened to the floor, but in the dining-room of our bodily dwelling the little eaters themselves are fastened and cannot run away, so you may think it is no particular credit to them that they are always found at home.

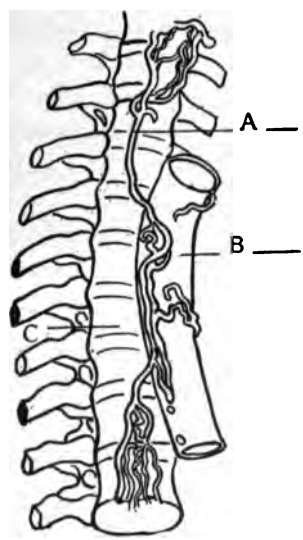
Under the microscope they look like little fine hairs, and give the walls a velvety appearance. They, too, have a Latin name; one is called a villus, and all are called villi, just as we say "Mr. Jones" when we speak of one, and the "Joneses" when we mean the whole family. How do you

suppose the Joneses would feel if, when they came to breakfast, they should find the meat and potato, and bread and milk, and fruits and coffee had all been pounded and ground and mixed together in one thin gruel-like mass (I am afraid they would say mess) and they could not say whether they would take eggs or oatmeal, or buckwheat cakes, or biscuit, but were just obliged to take the gruel and be satisfied? That is the way with the villi. They have no choice in the matter; they are obliged to obey St. Paul and "eat what is set before them, asking no questions."

Everything that has passed through the kitchen and store-room is mixed into a thin, milky gruel called chyle, and the villi work away sucking it in for dear life; yes, for our dear life, for they are eating that we may live. They are simply taking up this chyle to pass it on, that it may go to build us up.

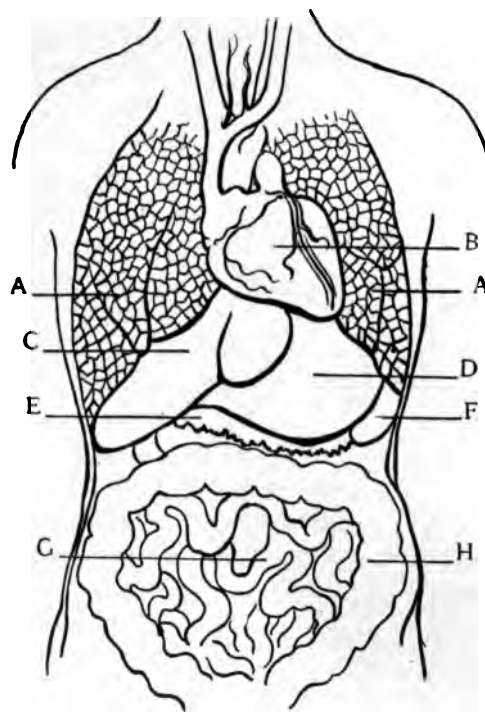
We know that the food we eat is made over into our bones and flesh and nerves; but how does it get into the blood so that it can be carried to the various parts of the body? The sugar that is digested in the stomach goes directly into the blood with the water, both being absorbed by the walls of the stomach. In the intestines, the villi suck up the milky chyle and gather it into vessels called lacteals from the Latin word *lac*, meaning milk.

These lacteals are held in the folds of the mesentery, and are connected by fine canals with other vessels called lymphatic glands, which vary in size from that of a pea to a small almond. There is said to be about one hundred and fifty of them.



A, Lymph tube. *B*, Duct. *C*, Spine.

They are spongy in structure, and when the lacteals pour their fluid contents into these lymphatic glands, you can understand how they take up the fluid as a sponge takes up water. After soaking through the glands and undergoing some



A, Lungs. *B*, Heart. *C*, Liver. *D*, Stomach. *E*, Pancreas. *F*, Spleen. *G*, Small Intestines. *H*, Large Intestines.

CHAPTER XIII.

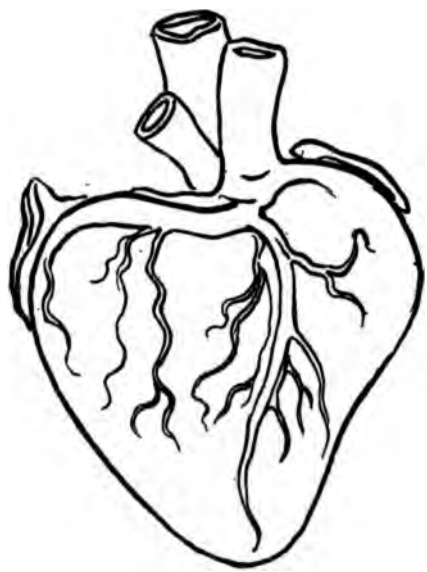
THE FORCE-PUMP.

IN the very centre of our bodily dwelling we have a strong force-pump that sends fluids to all parts of the house. It is located in the third story, or thorax, and is so wonderful that I am sure that we shall delight to study it. It is about as big as your fist and is conical in shape. It lies obliquely in the thorax with the base uppermost and toward the right, while the point touches the left side between the fifth and sixth ribs. A bright little boy who was asked where the heart was located exclaimed, "Oh, I know. It is north of the stomach."

Put your chin down on your chest as low as you can; now place the wrist of your right hand on this point, with your finger tips about over the fifth rib on the left side, and you will see just about where the heart lies. "Oh" you say, "the heart cannot be away up there, for we feel it beat down on the side, and not at all up in the middle of the chest!" That is because the tip of the heart comes close to the walls of the thorax and

touches them at every beat, while the base lies back of the lungs and its beating cannot be felt, though it can be heard if you will listen at this point.

This little pump begins to work long before



THE HEART.

Aura comes rushing into the lungs, and it is the last organ of the body to stop working. In very small children it works very fast, perhaps making one hundred and thirty strokes a minute, but it gets over its hurry as people grow older, and in adults it usually beats about seventy-five times a

minute; however, that differs in different people. If you put your finger on your wrist on the thumb side, yon can feel the beating of the pulse, caused by the stroke of the heart sending the blood through the arteries.

The heart is a hollow muscle, but it is not like the muscles on the outside of the body. These are controlled by the will, but we have not been given control of the beating of the heart. And that is a fine thing for us, for if we had to manage it all the time, we should be able to do little else. We could not go to bed, as we do now, and sleep soundly, feeling sure that this little force-pump would work away all night just as it had worked all day. Does it never rest, then? Oh, yes, it rests between beats. It makes a stroke, and then it rests, then it beats again, and so it keeps on from the first moment of life to its end. It does not get much rest, does it? And yet I think it rests more than you may imagine. Scientists have made such accurate calculations that we now know that the heart rests fully five-eighths of the time, which really makes about fifteen hours of the twenty-four.

I think you will be suprised to learn what a vast amount of work the heart does. As I said, it is a hollow muscle, and is divided into two parts, a right and left heart, as we say. Now, don't tell

somebody that I said we have a heart on the right side, and another on the left side, for that is not true. We have a right and a left heart, but both are enclosed in a sac, the *pericardium*, which means around the heart. Each division is again divided; the upper part on each side is called the *auricle*, and the lower one, the *ventricle*. The right and left sides of the heart are entirely separate from each other with no door of communication between, but the auricle of each side is connected with the ventricle of the same side by an opening, and this opening is closed by gates called valves, which are really folds of the membrane lining of the heart. These gates swing from the auricles into the ventricles, but never the other way because fleshy strings are fastened to them that let them swing only until their points come together, thus entirely closing the opening.

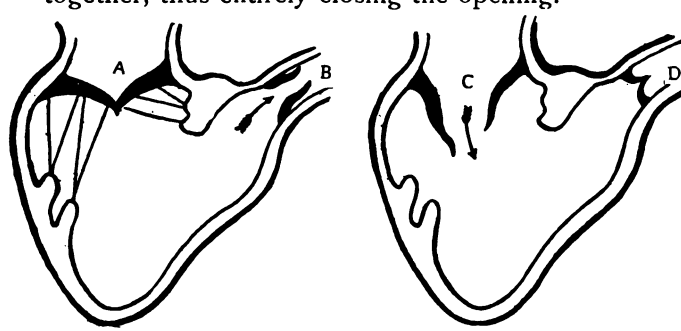


DIAGRAM OF HEART SHOWING VALVES.
A, Valve closed. *B*, Valve open. *C*, Valve open. *D*, Valve closed.

But how much work is done by the heart in twenty-four hours? Physiologists differ in their calculations, but we must always remember that the size of the heart varies in different individuals.

If a man weighs 150 pounds and his heart beats seventy-two times a minute we can come pretty near finding out the amount of work it does. The blood equals one-thirteenth of the body weight and the whole amount passes through the heart in fifty-three beats. The capacity of the heart in this man will be about three and one-half ounces, and in less than ten minutes his heart will have pumped an amount equal to the weight of his whole body, and this is more than ten tons in twenty-four hours. But this does not accurately measure the force it uses, for we must multiply the weight by the distance it is lifted. If we say we lift one pound one foot high, we know just exactly what we do, and we call this a foot-pound. If we lift four pounds four feet high, it is the same as lifting one pound sixteen feet high, or sixteen pounds one foot high, and so we call it sixteen foot-pounds. At every beat of the heart three and one-half ounces are sent from the left ventricle into the large artery called the aorta. If there were no walls to confine it, we are told that the blood would jet six feet high at each stroke, so you see at each heart beat, enough force is used to

send three and one-half ounces six feet high; or, to put it the other way, it could send twenty-one ounces one foot high, or one ounce twenty-one feet high. Multiply twenty-one ounces by seventy-two, the number of heart-beats and we find that force enough is used to send one thousand five hundred and twelve ounces one foot high, or one ounce one thousand five hundred and twelve feet high. Now go on with the problem. Multiply one thousand five hundred and twelve by sixty, the number of minutes in an hour, and that by twenty-four, the hours in a day, and the result is 136,000 foot-pounds lifted by the left ventricle alone.

The walls of the left ventricle are thicker and stronger than those of the right, because it must send blood to all parts of the body, while the right ventricle only sends it to the lungs.

What a marvelous little force-pump the heart is!

Should we not use it well and give it time to rest?

Count your pulse when you are lying down, and then when sitting up, then when standing, then after you have been running, and you will understand that the heart has the most time to rest when you are lying down. We need to exercise, to make the heart send the blood vigorously to all parts of the body, and then we need to lie down and sleep that it may have time to rest and gain strength for a new day.

CHAPTER XIV.

THE GENERAL MANAGER.

I FANCY your father would think he had made a fine bargain if, when he bought a house, he should be told that all he would need to do to keep it in repair would be to bring the mortar, glass, nails, wood, and other materials, and the house would help itself to all that was necessary. In truth, that is all we have to do to keep our bodily house in good order. We cannot furnish the glass, but we must furnish the material out of which glass is made. We do not furnish bone but the material from which bone can be made, and so it is with every part of the house. And if we do not furnish the right kind of material in the right quantity, the house falls into decay, or gets out of repair, and this we call being sick.

In our homes there is usually some one who superintends the housekeeping. Have we no such general manager in our bodily dwelling? Oh, yes, indeed. Her name is Blood, and a very active, busy little worker she is, if we give her half a chance. She goes about the house day and night,

DIAGRAM OF THE BLOOD VESSELS.

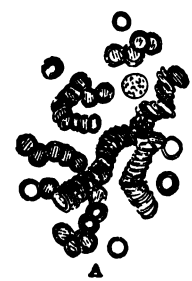
never stopping, but seeing that everything is in order. If I were to paint her picture it would be as a jolly, round little body, with a scarlet dress, and a white cap on her head.

A large passage called the aorta leads from the left side of the heart, and this divides and subdivides into many small halls, called arteries, and and these into still smaller ones, called arterioles, and these again into some so small that they are known as capillaries, a word meaning hairs. These capillaries are found in every part and every organ of the body. When we stick a pin into the skin, and it bleeds, it is because we have pierced a capillary. These capillaries are gathered up in the larger vessels or tubes, called veins, and these into still larger ones, until at last two large veins, the *vena cavae ascendens* and the *vena cavae descendens*, enter the right side of the heart.

The arteries carry pure blood and may be likened to water pipes. The veins carry impure blood and are, therefore, like drainage pipes. So you see the arteries and veins belong to the plumbing of the house; and as it is through them that blood goes to all parts of the body, we could not very well describe them until we came to talk of our general manager.

The fluid part of the blood is known as the *blood-plasma* from the Greek word meaning to

form. It is so called because it carries the building material out of which the various tissues are formed. This blood-plasma filters through the capillaries into the tissues and is then known as lymph. In this plasma float cells or corpuscles, some red and some white, about one white one to four hundred and fifty red ones. That is why I said the dress of the house-keeper was red and her cap white. The red corpuscles are in shape like pieces of money hollowed out on both sides. They find their way in crowds through the arteries down into the tiny capillaries where they are obliged to go in single file.



A

CORPUSCLES OF HUMAN BLOOD, HIGHLY MAGNIFIED.

They carry oxygen which slips through the walls of the capillaries along with the lymph and so is brought to each tissue the peculiar food it needs to keep it in repair.

The dead or waste material is collected with the lymph and carried to the veins. As the blood then goes through the lungs, the carbonic acid gas is thrown out. Some of the dead matter is thrown off by the skin. In the liver the blood goes through certain changes so that waste material can be sent to the kidneys to be elimi-

nated in the form of urea, and that is the way our bodily housekeeping is done.

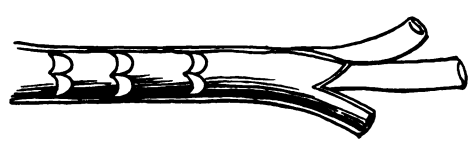
Blood carries with her a peculiar substance called fibrin which prevents her running away whenever the blood vessels are injured. It might almost be called her conscience. You know that sometimes when you are tempted to do a wrong, there is something in you that stops you. Perhaps you think you will play truant, but this invisible something seems to tie your feet and you cannot go. We call this conscience. The fibrin of the blood is that substance which forms a clot. You have perhaps seen a clot of blood, but have not thought how important it is that blood should clot, or coagulate, as it is called.

BLOOD VESSELS.

If freshly drawn blood is whipped with twigs, we can see in it little fine white threads. This is the fibrin, and is what makes a wound stop bleeding of its own accord, by catching the red corpuscles and forming the clot. It is just as if Blood carried strings in her pocket, and when she finds a

temptation to run away through an open door, she ties her own feet so she cannot go.

You will readily understand that Blood never rests. Night and day she hastens on her round of duties. She starts out rather briskly impelled by the force of the heart, and runs through the arteries at the rate of twelve or fifteen inches per second, but in the capillaries she does not go faster than one-fortieth of an inch a second, for here it is that the real work of the housekeeping is done, and she must go more slowly in order to attend to business. When she gets to the veins, she finds little gates or valves that shut behind her and prevent her going back even if she wanted to.



VEINS, SHOWING VALVES.

Here she cannot feel the impulse of the heart so strongly to hurry her along, and if she is away down in the feet, she has a long distance to climb; but the valves close behind her, and if we are exercising, the muscles press upon the veins and hurry her along. The action of the lungs in breathing gives her a new impulse, and so Blood is impelled through the veins to the heart.

Sometimes there is in the house a general disturbance which we call a fever. The force-pump works very fast and Blood rushes through the halls in great haste and unless something is done to make her cool down and move a little more gently, Man may actually be compelled to move out of his house and leave it.

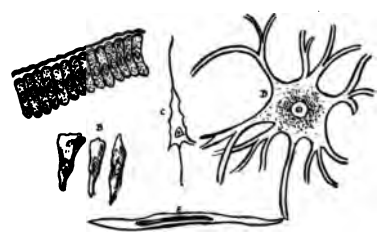
CHAPTER XV.

THE SERVANTS.

WE may, in a general way, call the hands and feet servants, but they are only automatic servants obeying man's will as machines; we will therefore think of them only as appendages. Did you never wish that a dish-washing machine could be invented? Well, you see that in your hands you have a most complete one. Nothing could be made so perfectly adapted to its various uses as the human hand with its bony frame-work, muscular machinery, and electric wires of the nerves. Man is the animal with the thumb, and the possession of that little organ gives him great superiority. Experiment, and see how few things you could do well if you had no thumb, and you will come to prize that part of your hand more than you have ever done before.

But we are now going to talk of the servants of our bodily dwelling. The principal servants are the cells, and marvelous little creatures they are. Cells are little sacs containing a jelly-like fluid which looks much like the white of an egg; some

are so very small that over three thousand of them could be laid side by side in the space of an inch. There are nerve cells, muscle cells, brain cells, and red and white blood cells. And each particular cell understands and does its own peculiar work and selects its own food out of the general mass. The blood cells have the power of changing their form. Every activity whether of body or brain, whether muscular exercise, or



A. Cylindrical Epithelium cells, from intestines. (Magnified 150 diameters.)
B. Intestinal Epithelium from Jejunum. (Magnified 150 diameters)
C. Brain Cell from Cerebral Cortex. (Magnified 100 diameters.)
D. Nerve Cell. (Magnified 100 diameters.) *E*. Smooth Muscle Cell.

speech, or thought, or emotion, causes some change in tissue, uses up or destroys cell-substance; but new material is constantly being added in the place of that which is destroyed so that while we are continually dying we are continually being made over anew.

You may call these cells, then, general servants, each having a certain line of work to do, and

doing the work always as perfectly as possible with the materials furnished. The general manager, Blood, brings materials to the tissues, and the cells governing the growth and repair of the bones select from it the different forms of lime, magnesia, and soda that are needed to build up the bones and keep them in good order, while from the same store of material the muscles and the nerves search for the albumen, glycogen, and other material which they need.

Cells are constantly busy with different kinds of work. First, we may say their work is to absorb nutrient material, each tissue searching out that which it especially needs. Second, their work is to make that material over into some part of the body. Of course, before new material can be put in any part of the body, the dead material must be removed, and so, third, a part of cell work is to gather up waste matter that is of no further use, and cast it out, just as the workmen gather up the pieces of lime and mortar or broken glass after they have done a job of repairing. Fourth, cell work is to increase the size of the organ. In people who have their growth, the cells have only to remove the worn-out matter and put in new: but children are growing all the time, so, in them, the cells must be continually adding new material.

All over the body these tiny, living cells are

busy, busy; the liver cells are making bile, liver-sugar, and separating waste matter; the cells of the glands are making saliva, gastric juice, and other digestive fluids; and other cells are making the coloring matter that paints our skin.

If the body is injured, the cells at the border of the wound go to work to heal it by filling up the space with new material. We talk sometimes about salves and ointments having healing power, but the healing power really lies in the ability of the cells to make new tissue. The salve acts only as a protection.

Cells are often very kind and helpful and will undertake to work for each other. Thus, if the skin has been chilled, the mucous membrane will try to do the work for it, and that is why there is such an increase of mucus in the nose or bronchial tubes when we have a cold. If the kidneys do not work well, the skin tries to help throw out the waste matter, and so we find all over the house the various servants are kindly helping each other, for they are all related, and they seem to know that if any are sick they will all soon suffer.

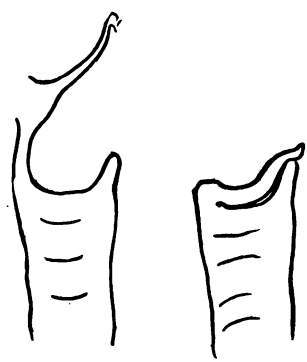
CHAPTER XVI.

THE PURIFYING APPARATUS.

BETWEEN the windows of the eyes begins the sloping roof of the porch we call the nose, covering the two circular doorways through which the good fairy Aura goes in and out of the house. This porch has a bony, cartilaginous framework and muscular walls. Its interior is divided into two passages called the nasal fossæ. These passages, like all cavities opening to the air, are lined with mucous membrane which secretes the semi-fluid called mucus. It used to be thought that this mucus in the nose came from the brain, but a man named Schneider discovered that it was made by this membrane, and the membrane is therefore called the *Schneiderian* membrane.

Aura mounts the dark stairway, not hindered by the hairy guards stationed there to keep out intruders; she descends through the winding passages into the hall of the pharynx, and, crossing the head of the kitchen stairs, she finds in her path a little trap-door called the epiglottis. This being raised, Aura passes down another stairway,

the trachea, into the laundry or lungs, which occupy the larger part of the third story of the house, known as the thorax. This stairway of the trachea differs from that which leads down into the kitchen in the fact that the walls are firm and



TRAP-DOOR OPEN. CLOSED.
DIAGRAM OF TRACHEA.

do not lie close together as do the walls of the œsophagus.

The trachea, sometimes called the wind-pipe, is about four and a half inches long. At the top of it is the wonderful musical instrument, the larynx, through which Aura gently passes, usually making no noise. At the bottom of the trachea two passages branch out to the right and left. These are called the bronchial tubes. They divide and

subdivide into still smaller tubes until they become exceedingly fine, but still Aura finds her way through them to the place where each ends in a small room known as a pulmonary lobule, where are placed the stationary tubs or air cells.

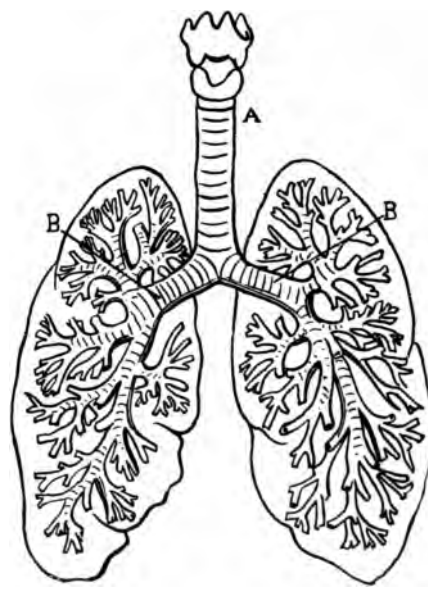
Here it is that the most wonderful washing process takes place, the washing of the blood by the air. We may perhaps think that if Aura is a fairy she will not do such menial work as washing, but that which she does is like the wonderful stories we read, where the fairy waves a wand and says, "abracadabra, presto change," and all is done.

Monday is often spoken of as the day when there are "picked up" dinners, and all sorts of discomforts. In some parts of the old world, washing-day comes once in three months among the poorer people, and once a year among the rich, and then a great ado is raised. Numbers of washer-women are called in, big fires are built, and there is rubbing and scrubbing that goes on for a week before all the soiled clothes that have accumulated during the year are cleansed.

But every day is wash-day in our bodily dwelling, and if the other business of the house were much disturbed by the process, we should be in "hot water," or "suds" all the time. But in truth the work goes on so quietly and systematically that

we think little about it, although we become much distressed if, for any reason, Aura is interfered with in her work.

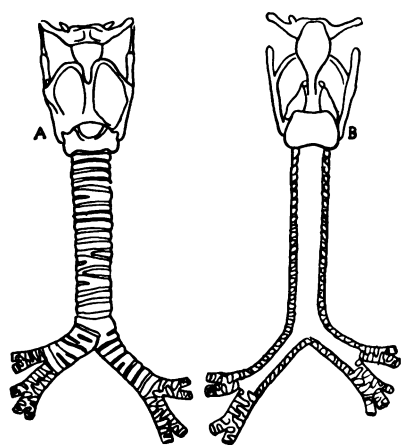
In order to understand what she does we will



THE LUNGS, SHOWING THE LARYNX.
A. The Windpipe. *B*. Bronchial Tubes.

have to learn a little more about the structure and purpose of the lungs. First let me point out to you that the trachea is made with firm walls of cartilage or gristle, but the rings of cartilage do

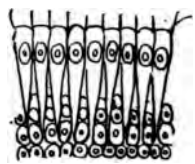
not go all the way around, for if they did they might interfere with the working of the œsophagus, and prevent the food from passing down into the stomach. So, just at the back, where the œsophagus and trachea lie together, the cartilaginous rings of the trachea are finished by muscular fibers.



A Front and *B*. Back of Trachea.

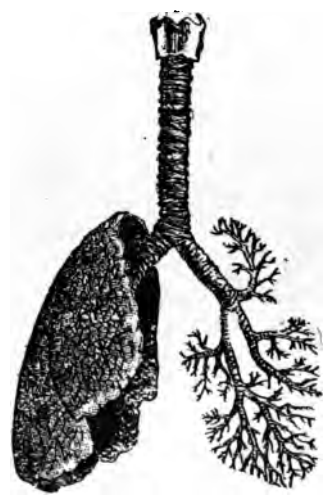
The walls of the bronchical tubes are stiffened with cartilage so that they will stay open. All these passages are lined with mucous membrane, and here are stationed very fine and delicate attendants called cilia, who keep up a constant bowing motion toward the trachea, and so help Aura to

take back again to the outer world any intruders who may have found their way in.



CILEATED CELLS.

The bronchial tubes and air cells make up the lungs, hung like two air bags in the cavity of the thorax. This cavity is lined with a membrane called the pleura which is reflected back and covers the lungs. This membrane secretes a fluid that makes the lungs move easily

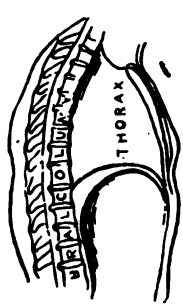


TRACHEA AND AIR-TUBES — ONE SIDE COVERED BY LUNG.

as the two coats of the pleura play upon each other in breathing.

You have not forgotten that the thorax is framed with the spine and sternum connected by the ribs, twelve on each side. These ribs are so attached to the spine and sternum that they are to quite a degree movable, and the strong muscles are so arranged as to lift them upward and outward at each breath. When those lift, the cavity of the chest grows larger and this is an invitation to Aura to come in and fill the space, which she quietly does. But the cavity is enlarged not only from side to side, but from above and downward.

You can make a little contrivance to illustrate the motion of the ribs in breathing. Take a stick and drive into it two nails opposite to each other. Drive them so that they will point out, down, and just a little back. This illustrates the way the ribs are attached to the spine. The ribs may be represented by two wires curved and attached at one end to the nail. Raise the free ends and notice how the space between them increases. In just this way the cavity of the chest is increased by the raising of the ribs in inspiration.



The floor of the thorax is a strong muscular partition that acts also as a roof or ceiling to the

abdominal cavity. There are openings through it for the kitchen stairs and for some of the plumbing and electric wires, but it closes tightly around these so that there are no open spaces in it. This muscular partition is called the diaphragm, and it is a very important breathing muscle. The floor formed by it is like a dome swelling up into the thorax. It is fastened along the lower border of the ribs, thus making the front side shorter than the back. When we breathe in, it flattens or grows "taut" as a sailor would say, and the sides are pulled outward by the lifting of the ribs and the diameter of the body at this point is increased and the abdominal viscera are pushed downward. When we breathe out the diaphragm relaxes and the abdominal organs returning to their places push it up in the center and restore its dome-like shape.

An idea of the movements of the diaphragm may be obtained by opening and shutting an umbrella. When you open the umbrella, its diameter increases and the silk is tightly stretched. When you partly close it, the diameter is shortened and the silk is loose. If you had an elastic cylinder around the umbrella you would see it would need to stretch a good deal as the umbrella opens. The body is an elastic cylinder around the diaphragm and naturally grows larger when

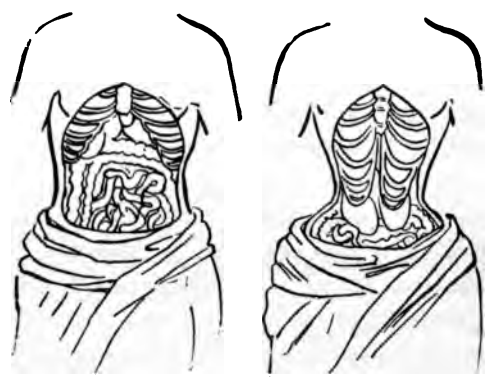
breath is taken in and the diaphragm grows tense and is stretched.

If tight clothing is worn, the body cannot expand and the action of the diaphragm is interfered with, the lungs are not completely filled with air, and serious results follow. The upper muscles of the thorax work harder to lift the ribs further, and we have a great heaving of the chest. Some people have supposed that because women breathe in this way it is proof that this is a feminine style of breathing. But, in truth, it is only an effort to take air into lungs that are so compressed by bands and tight clothing that they cannot expand at the lower part as they should. It has been learned that a man dressed in the same way will breathe with the upper part of his chest in the so-called feminine fashion.

We sometimes hear women say that they cannot sit up unless they have on corsets to support them. If we should see a person putting an iron band around his dwelling, and he should tell us that it would not stand up without this band, we should at once say that he must have employed a very poor builder; but we know that our divine Architect does not do such poor work; and if the bodily house cannot stand erect without stays, it is because the muscular walls have not been used, and thereby have become weak. Now that girls of the

present time are using their muscles vigorously in out-door sports, we find that they, as well as boys, can grow up with firm walls that will hold them up without external aid.

But some people have an idea that the body is not so beautiful if left as the Creator made it as when it is made over and drawn in to give a slender effect. If we take a peep inside and see



NATURAL FIGURE. DEFORMED BY LACING.

what is done to the internal organs, I think we shall come to have a different idea of beauty.

We are not fond of tiny rooms in our dwellings. We don't like to have the furniture all crowded so closely together that we can hardly walk through. We never hear people boast of how small a house they have, unless it is their bodily house they are

talking of; and then they sometimes like to tell how they can squeeze it into the smallest possible compass just over the rooms that contain the most precious furniture. The lower part of the laundry is thus compressed so that Aura cannot get in; the working of the force-pump, the heart, is hindered; the kitchen is squeezed so that it cannot churn the food properly; that wonderful laboratory, the liver, is pressed quite out of place, and perhaps, worst of all, the dining-room is pressed down out of the proper place in the abdominal cavity until it rests upon the contents of the pelvic cavity, thus creating a great deal of pain and trouble.

Is it not queer that women, who are such excellent housekeepers and who are so distressed if their dwellings are out of order, should so persist in disarranging the furniture of their bodily houses and claim that it adds to their beauty? I think, however, that it is because they have not studied the construction of their own bodies.

I am sure that you who know about the marvels of yourself and the work that is being done in your body, will not interfere with the efforts of the kind servants who work night and day to keep you alive, by making them live and labor in a room so small and restricted that they cannot do their work well.

In order that you may understand the wonderful washing that goes on in the laundry, we shall have to study about the changes that take place in the blood that make it need cleansing. I have told you that we are constantly using up material, and one office of the blood is to gather up the little dead particles that result from all the activities of life. The blood also brings back to the tissues that which will replace what they have lost. The blood comes into the lungs dark and impure: it gives up its carbonic acid gas and by taking up oxygen is changed from its dark color to a bright scarlet. We will not forget that these two gases are carried by the red corpuscles. This giving out of one gas and taking up of the other is the washing process. There is no rubbing and boiling and rinsing and starching, and after the washing is done, no scrubbing to do. The blood runs through minute channels in the membrane of the air cells and the air fills the cells on the other side of the membrane. The carbonic acid gas slips through the membrane from the blood into the air, and the oxygen slips through the membrane from the air into the blood, and the washing is done.

Eighteen or twenty times a minute Aura comes in bringing in the supplies of oxygen and goes out with the carbonic acid gas, and the more deeply we breathe, the more perfect will be the cleansing

of the blood. Dr. J. H. Kellogg says that every time we breathe we spoil at least a half barrel of air, or six hundred barrels every hour. This gives us a very good idea of how needful it is to have some way of letting pure air into the rooms we inhabit. If every door and window is tightly closed, and the fire and lights are burning, using up our oxygen as they must in order to burn, we cannot wonder if we have a headache, and feel stupid, for we are poisoned by breathing in the waste matter from our own lungs and we are not taking in oxygen to give us new material. Tracy says that a five-foot gas burner creates as much carbonic acid gas as five men.

When we say that we spoil one-half barrel of air at every breath we, of course, do not mean that we breathe out that much, for the lungs do not hold more than one and a half gallons of air, and we do not empty them fully at each breath. About a pint of air is taken in and breathed out in moderate breathing, and this we call tidal air because it ebbs and flows like the tide. When we run or exercise briskly the heart beats faster, the lungs work harder, and we take in more air, three times as much, perhaps, and this is called complemental air. When we breathe out this fuller amount, it is called reserve air, because we had it reserved for some special occasion which demands

more than the ordinary tidal air. But after we have breathed out all that we possibly can, there still remains as much more that we can by no means empty out of the lungs, and this is called residual air. Residual means that which remains, so we can see why it gets that name.

The question may arise in your minds, how can oxygen get to the little tubs of the air cells to wash the blood, if not more than one-tenth of the air is changed at every breath? I will see if I can explain that. You see that the air going out of the lungs is not like people going out of a room, where those near the door must go out first before those at the further side of the room can go out. To explain the change of air in breathing we must study the law of diffusion of gases. That sounds as if it might be very hard to learn, but like many other things it is much easier than you might think. Gases are very light substances. They are very friendly and mix readily with, or diffuse through each other. Air is composed of gases, and when it is breathed in, it contains one part oxygen and four parts nitrogen with a very small amount of carbonic acid gas. It gives up oxygen to the blood in the lungs and in return receives from the blood carbonic acid gas, so that the air that is breathed out has less oxygen and more carbonic acid gas. As the air was breathed

in, the gases began to mingle all through the lungs until they were equally distributed, and then the oxygen that was near the walls of the air cells passed through them into the blood, and so we see that although the lungs are never entirely emptied, yet the whole volume of air is changed at each breath.

The walls of the air cells are so thin that ten of them would not be thicker than this paper; and if all that are contained in one pair of lungs could be spread out over a flat surface, it would cover a space equal to 250 square yards. You see there are about 700,000,000 of these little tubs in our laundry, and each one made of this delicate membrane, so we can get an idea of the amount of washing done at one breath.

But if we send out so much carbonic acid at each breath, how does the outside air keep pure? Because the trees and plants take up the carbonic acid gas and give out oxygen, and so they purify the air which we pollute. That is why the air of the country seems so sweet and pure, and why plants and "green things growing" are so necessary in cities. Little parks in the midst of great cities are not only a beauty but a need, and the plants in houses help to purify the air as well as to make the home look bright.

CHAPTER XVII.

THE HEATING APPARATUS.

THERE are many remarkable things about the body as you have already learned; but I have one more marvel to tell you now, and it is that no matter how cold or how hot the weather may be our bodily temperature remains about the same, and we begin to ask, "Where are the stoves that keep it warm?"

Some dwellings are heated by hot air from a furnace, others by steam, others by natural gas, or wood, or coal burned in stoves or open grates.

Our wonderful house has a combination of methods. We all know that a fire will not burn unless it has air. In the process of burning, the oxygen of the air unites with the carbon of the fuel. This is called oxidation, and by it carbonic acid gas and other products are formed. Again we find our good fairy Aura with her assistant, Oxygen, helping to keep us warm. Oxidation is a chemical process, and chemical processes are usually accompanied with the formation of heat. Foods, as we have seen, consist of carbon, hydro-

gen, nitrogen, and oxygen. These are taken into the body and undergo a process by which the carbon and oxygen unite to form carbonic acid gas, and the hydrogen and oxygen unite to form water. This process is called oxidation of the tissues: and, as it goes on in every cell, we may call the cells little stoves.

In our study of the lungs we learned that oxygen is taken in and carbonic acid gas given out at every breath, and this process keeps up the fires all over the body in these little cell stoves. We might almost call the lungs and the pores the stove-pipes which carry off the smoke and bad gases. The more a man exercises, the more the cells will have to do to repair waste, so we learn how exercise makes us warm. It causes the cells to work harder, to burn more fuel and to demand more new material through the food for repair, and this demand we call hunger.

We can also understand why we are cold when we sit still. We do not take enough oxygen in the lungs to feed the stoves, and the lungs do not carry out the waste material very fast; the cells, not being called on to work very fast, do not generate much heat. If exercise produces heat, we can readily understand that active muscles are great sources of heat. By pressure on the blood vessels they increase circulation, and this brings

more oxygen to the tissues. Exercise uses up the tissue-cells and they call for new material from the blood, so you see heat is created by this process of decomposition or combustion, as we may call it.

Physiologists estimate that four-fifths of the heat of a healthy body is produced by the muscles. If you are cold and are sitting still you can know that the fire in your cell-stoves has died down very low, and the quickest way to rekindle it is to exercise briskly. Get up, shake your hands and feet, run, jump, and call the general manager, Blood, to go rapidly through the house and look after the fire, to rake out the cinders and ashes and bring new fuel, and soon the pipes of the lungs will carry out the deadly gases, and Oxygen will come in and start the fire to burning brightly. If the temperature is raised by exercise, it will not fall under an hour and a half. We can therefore understand that to sit still longer than that period of time will probably result in a slowing of the circulation that will make us feel cold. Digestion is a chemical process so we will not be surprised to learn that it produces heat.

Glands are organs that take material from the blood, and make out of it new material, so the gland-cells are also stoves. Mental exertion produces heat. The brain of a man who is thinking is warmer than that of a man who is sleeping, so

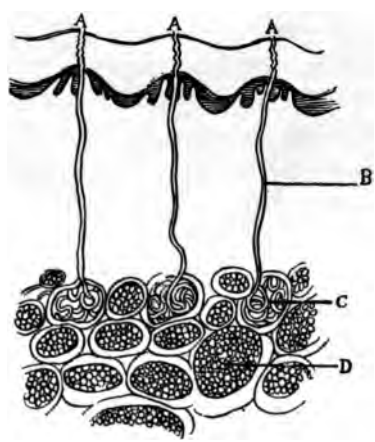
the brain cells are stoves too. The liver is the largest gland of the body, and in its work a large amount of heat is produced. Therefore we may call the liver a furnace. It does various kinds of work. It manufactures sugar and glycogen and one always needs a fire in a manufactory you know. It excretes waste matters and secretes bile, and these processes are chemical and produce heat, so we need not be surprised to learn that the liver is the warmest part of the body.

Perhaps it would be well to tell you just here the difference between excretion and secretion. Excretion is taking from the blood materials which are no longer useful, and casting them out of the body. The kidneys are excretory organs. Secretion is taking material from the blood and making out of it a new and useful material. The liver is both an excretory and secretory organ.

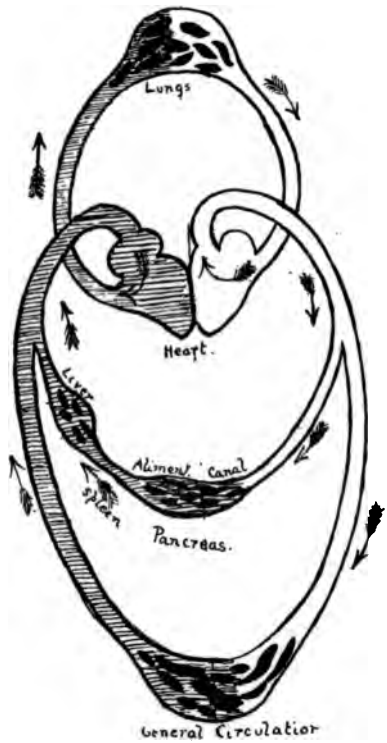
Do you ask if clothes do not make us warm? I answer that they keep us warm but they make no heat. They only retain the heat which our body makes, and the poorer conductors of heat they are, the better they will keep us warm. Linen is a very good conductor of heat and takes it away from the body so fast that it is not a very good article for winter clothing. Cotton is not so good a conductor as linen, but better than woolen, so cotton does not keep us as warm as woolen.

Our bodily temperature is about 98 degrees Fahrenheit (that means by the thermometer invented by a man named Fahrenheit), though it varies somewhat during the day. As we eat and exercise, the temperature of the body rises and reaches its greatest height between five and eight in the evening. While we are quietly sleeping it falls, and is lowest from two to six in the morning. If we sleep in the day and work in the night, this will be reversed.

The skin is the regulator of temperature; if we get too warm, all the little doors of the skin are opened, and water is poured out on the surface to cool us off



A, Pores of the Skin; *B*, Perspiratory Ducts; *C*, Perspiratory Glands; *D* Fat.


Lungs
Heart.
Liver
Alimentary Canal
Spleen
Pancreas.
General Circulation

CHAPTER XVIII.

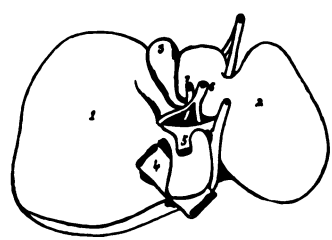
THE LABORATORY, MANUFACTORY, AND STORE-ROOM.

A CHEMIST is one who analyzes substances, or takes them to pieces and finds out of what they are made. The work of a chemist is done in a room called a laboratory. He does not find it difficult to take things to pieces, and he can unite many substances and form new ones; but he has not yet learned how to give life to the substances which he forms. He may take the elements of the human body in the right proportion and put them together, and yet he will not have a living body. There are vital processes as well as chemical processes.

We know that chemical changes are going on in all parts of the body all the time, so that the whole body might truly be called a laboratory, but I have given the name in this chapter to one especial organ which combines in itself a chemical laboratory, manufactory, and a store-room. This organ is known as the liver. It is the largest organ in the body, lies on the right side, close up

under the diaphragm, and fastened to it by ligaments, so that it rises and falls with every move ment of the diaphragm in breathing.

Wonderful work goes on in this organ, but, before speaking of it more particularly, I shall be obliged to tell you something about the portal circulation. In the chapter on the General Manager, we saw how Blood started from the left side of the heart and found her way into the farthest



THE LIVER.

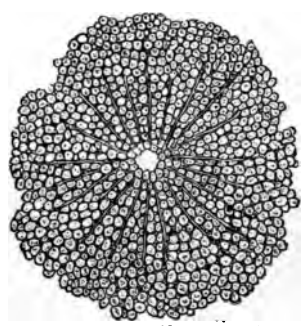
1 Right Lobe. 2 Left Lobe. 3 Gall Bladder.

extremities. All the blood does not go down to the feet, but some of it takes a short cut across to the liver through a union of intestinal blood vessels, forming what is called the portal circulation. Through this some products of digestion go directly to the liver and pass through certain changes before being thrown into the circulation.

A piece of liver has no great beauty until we come to examine it under the microscope, then

we find much in its complicated structure to admire. It consists of lobes which are made up of innumerable small lobules, and the veins wind about these lobules and between the lobes, and from these numerous capillaries are given off, until the whole looks almost like lace-work. This system of lobules, capillaries, and veins is engaged in a variety of work.

The liver has the power of changing into urea the poisonous materials which are brought with



LOBULE OF LIVER MICROSCOPICALLY EXAMINED.

the blood and are a result of the breaking up of tissues in all parts of the body.

One of the greatest offices of the liver is the manufacturing of bile, which is secreted continually and stored up in the little reservoir called the gall-bladder. During digestion the greatest amount of bile is poured out, and during fasting it

may entirely cease. A free use of water increases the secretion of bile. The amount is also influenced by the quantity of food we eat; the largest amount is made when we eat flesh food, a less amount with vegetable food, and a very small amount with pure fats. We learned much of the work of the bile in the chapter on the butler's pantry. The liver also makes what is known as glycogen, a kind of animal starch. You remember that all starchy foods must be changed into sugar before they can be absorbed, and the liver takes this sugar, makes it into glycogen, and stores it up until needed for use in the body, and this is why I call it a store-room. The amount of glycogen is increased by the use of starchy foods or by foods containing a large amount of sugar.

The movements of the diaphragm assist in forcing the bile out into the excretory duct. A relatively small amount of restraint will cause the bile to stagnate in the bile duct, and this fact is of importance when we remember that the pressure of tight clothing comes directly over the liver. It must not be forgotten that interference with the formation of bile will be an interference with the process of digestion and absorption, and will therefore have a serious effect upon the general health.

CHAPTER XIX.

THE HOUSEKEEPER'S CLOSETS.

YOU may be a frequent and familiar guest in a household and feel free to wander through its various apartments at will. You visit not only the library and the living room as you wish, but you also go to the dining-room and kitchen. Perhaps the housekeeper shows you with pride her linen closet and her china closet, or the one where her canned fruit is stored; but, in all probability, she does not open to your explorations the closet where she keeps the rag-bag or the half worn clothes she intends to remodel. There are some processes in her housekeeping that she prefers to keep to herself.

Even so in our bodily house there are rooms where work is carried on which our physiologists have not yet come to understand. It is a little strange, when the body has been studied for so many hundred years, that there should remain any part of it not fully understood. Do you open your eyes a little when I say so many hundred years, thinking I must be mistaken? If I am, then some

wiser people than I are also mistaken, for Landois and Stirling in their physiology tell us that Aristotle said, three hundred and eighty-four years before Christ, that the heart propelled the blood to all parts of the body, but it would seem that he did not know that the blood came back to the heart, although he named the aorta and the venae cavae.

About 300 B. C. two renowned doctors gave the arteries their names, thinking that they carried air because they were always empty after death; but in 131 A. D. Galen contradicted this idea because he found that blood always flowed from a wounded artery. Michael Servetus, whom Calvin caused to be burned in 1553 A. D., discovered the circulation of the blood in the lungs, and in 1604, William Harvey demonstrated the complete circulation of the blood. In Cicero a distinction is made between venous and arterial blood. In 1608, Borelli estimated the amount of work done by the heart, and in 1661, by means of a microscope, Malpighi discovered the capillaries.

This indicates but a small part of the investigation of the body during the period previous to the last date. Since then, students of physiology have been innumerable; the aids of science have vastly increased, and the functions of most organs of the body have been watched and accurately

described. But there still remain a few rooms in the bodily house which are as mysterious as those to which Blue Beard gave Fatima the key. We are not afraid, however, that they contain ghastly visions of murdered victims. These puzzling rooms are not locked against our entrance; the doors are open: we may walk in and pry around as much as we please, but, with all our prying, we are as yet only able to guess what is done therein. But I am inclined to think that they may appropriately be called the housekeeper's closets.

Two of these rooms are located at the back of the reception room, one on each side. They are called the tonsils, and ought not to be visible; however they are often so enlarged that they quite fill up the throat and may interfere with the breathing. Stohr says that great quantities of white corpuscles wander out of the tonsils, but he says nothing of their wandering into them, so we can infer that the tonsils may possibly manufacture white blood cells.

At the base of the brain are little groups of cells forming the pituitary body and the pineal gland. Most of the glands of the body have ducts or passages leading out of them, but these rooms, which I call the housekeeper's closets, are known as ductless glands because there is no duct or canal to carry away whatever may be manufac-

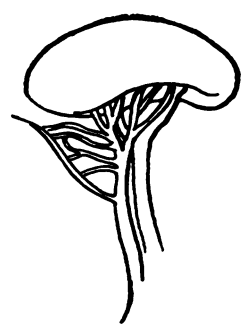
tured in them. One of these, the thyroid gland, consists of two lobes, one on each side of the larynx, connected by a cross-piece. We do not know what this gland does, but when it is taken out of an animal we know that the animal has tremors, that there is alteration of the motor power, difficulty in breathing, degeneration of the connective tissue and mucous membrane, wasting away of all the tissues, especially the muscles, a diminution of the red corpuscles, a great increase of white corpuscles, and finally, imbecility and death; so we can see that a very important work must be done in this little glandular closet, even though we do not understand it.

The thymus gland is another ductless gland located partly in the thorax, and partly in the neck. It increases in size during the first two or three years of life, then remains stationary until the tenth or fourteenth year, when it begins to grow smaller, and finally almost disappears. It is supposed that it has the functions of the true lymph gland.

Over the top of each kidney is fitted a little cap called the supra-renal capsule. It belongs with the mysterious rooms, and is supposed to have something to do with regulating the amount of pigment or coloring matter produced in the blood. This is a guess based upon the fact, that, when

they are diseased, the skin becomes brown in color.

The largest and most important of these puzzling rooms is called the spleen. It is located in the left side of the abdominal cavity above the hip. Its structure is much like that of the sponge. It is largely supplied with blood vessels but what it does, physiologists as yet have not been able to decide. Some assert that when the spleen has been removed, the lymphatic glands enlarge and



THE SPLEEN.

the blood-forming power of the red marrow of bones is increased.

I think I did not tell you about that property of the red marrow of bones. There are two kinds of marrow in bones, the red and the yellow; the yellow consists chiefly of fat, and is found principally in the long bones of the limbs. The cavities

inside the bones of the head and trunk are filled with red marrow which has the power of making new red blood corpuscles. I think these cavities in the bones may properly be classed with the housekeeper's closets.

But to continue concerning the effects of removing the spleen. The number of red blood corpuscles is diminished, the white ones are increased in number, while the lymphatic glands, especially those of the neck, increase in size. The experiment would seem to indicate that the spleen makes white blood corpuscles and destroys red ones. After a meal, the spleen increases in size, and is usually largest about five hours after digestion has begun, and this probably has some relation to the manufacture of white corpuscles. There is a relation between the spleen and the liver, for it is found that when the spleen contracts, the liver enlarges. It is observed also that depressing emotions, such as grief or sorrow, increase the size of the spleen, while the exhilarating emotions diminish it, so there may possibly be a real connection between the irritable mental condition of a person, which we sometimes speak of as splenetic, and the state of the spleen.

CHAPTER XX.

THE ELECTRICAL APPARATUS.

THE brain, as we have learned, is a busy workshop, and here is located the telegraph office through which Man sends messages to all parts of the house. The brain cells are the electric batteries, and the nerves are the telegraph wires. You will remember that the spinal column is made of twenty-six bones, with a hole in the center of each. These placed one over the other make a long tube, and in this tube runs a cord made of white and gray matter like the brain, only the position is reversed, the gray being on the inside and the white outside. A college student once defined the spinal cord as "the cord the vertebræ are strung on," which was not a very bad definition after all.

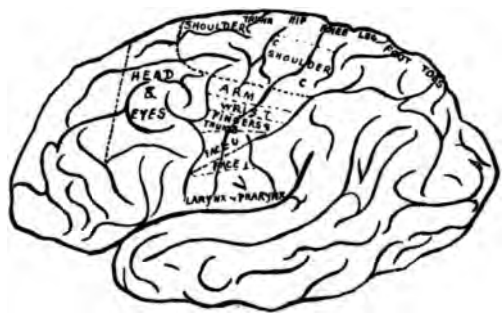
It is calculated that there are as many as nine hundred millions of the little cells in the brain, which generate the nervous fluid that corresponds to the electricity of the telegraph; and in the spine are other cells which we may call branch batteries.

From the brain twelve pairs of nerve-cables start out to carry the messages to the eye, the ear, the nose and other parts in the region of the head. From the spinal cord thirty-one pairs go to all parts of the body. These nerves form what is called the cerebro-spinal nervous system, because it originates both in the brain and spinal cord.

In the chapter on the general office we studied the structure of the nerves; now we will learn what they do. Nerve fibers of the cerebro-spinal system are of two kinds—those of motion and those of sensation, and one never does the work of the other. A knot of nerve cells collected together is called a *ganglion;* the brain is a collection of these *ganglia*, and in them is generated the nerve force. There are also ganglia in the spine which transmit and in some way modify the messages sent from the brain.

When we study the brain, we find that its various parts have each a special work to do. Certain parts have nothing to do with motion, but are centers for sensation or for special senses, as sight and hearing. Other parts of the brain have to do with motion only, and these are found in what is called the motor area of the brain. The motor area has lately been carefully studied, and we have learned to know through just what part of the

brain messages are sent to move the various parts of the body. Thus we have learned that one part of the brain governs the movements of the arms, another those of the legs, another the muscular movements of the face.



MOTOR AREAS OF THE BRAIN.

We know, too, that the fibers of the nerves cross from side to side of the brain to the opposite side of the spinal cord, so that the right brain governs the movements of the left side of the body and *vice versa;* an injury to one side of the brain will affect the opposite side of the body. This is very important in surgery, and to show you what skill physicians have gained in locating the cause of a difficulty, I will quote from a case reported in the records of the Philadelphia Orthopedic Hospital:— A young girl had fits of epilepsy; she said in the beginning of each attack that she suffered in the

right thumb. As the difficulty was of nervous origin the doctors thought they would see if taking out that part of the brain which governs the motion of the thumb would cure the disease. As she was a mill girl, and it was very important that the use of her hand should be preserved as far as possible, they were anxious to remove only so much of the brain as governed the movement of the thumb.

They opened the skull just over the part where they knew the nerve-center that governs the thumb is located, and cut out a piece of the brain about half an inch in diameter. By the use of an electric battery they decided that they had removed all of the brain that influenced the thumb, and judged that they had taken out all that was diseased. She recovered promptly and with perfect control of all the muscles of the shoulder, elbow, wrist and hand, but not those of the thumb. Every one of those were paralyzed. Now remember that only one-half inch of the brain was removed, yet the muscles of the thumb cover a good deal of space. One lies in the ball of the thumb; one between thumb and fore-finger; one in front of the forearm reaching almost to the elbow, and three on the back of the forearm extending half-way from wrist to elbow. But the most wonderful thing in regard to this operation I have yet to tell you. It was

performed in October, 1891; by June, 1892, she had regained the entire use of her thumb, which would seem to indicate that in this case new brain cells were formed.

Surgeons have also learned to locate the center of speech, written or spoken. Dr. McEwen relates the case of a Scotch Presbyterian who, after an injury to his head, suffered with "mind blindness." That is to say, his eyes were not injured, but he could not understand what he saw. He could see his well-worn New Testament before him but comprehended nothing of what it meant, nor could he read the well-known words. A surgeon removed a small piece of bone from the skull and found a small tumor pressing in that part of the brain which governs the center of written speech. Upon removing the tumor the man was entirely cured.

We are told by these scientific investigators that the area of spoken words is on the left side of the head unless the individual is left-handed, when this area is on the right side. Right-handed people, therefore, talk with the left side of the brain.

The cerebrum is the center of motion, speech, thought and feeling. The small brain, or cerebellum, regulates movements.

When an order is sent from the brain for the arms or limbs to move, it must go through a motor cell of the spinal cord, and from there be

re-transmitted. It seems as if the orders from the general office must be repeated at these little way stations to insure their being delivered at the right point; and messages of sensation which are sent from the surface of the body to the brain must also pass through the repeating stations in the spinal cord.

We know that we can feel even when we do not see, so we can easily remember that the nerves of sensation pass out from the back of the spinal cord; but if we want to act, we need to see, so we remember that the nerves of motion come from the front of the cord.

When we see how quickly a motion is made, after we have willed to make it, we can but wonder how fast the nervous current travels. If your hand were on a hot stove, a message would be sent to the brain that the hand was being burned, then a message would be sent back to the hand to take itself away from the stove, but it would all be done so quickly you could scarcely believe that two messages had passed over the nerves before you moved. It is calculated that a nerve-impulse travels at the rate of one hundred and ten feet per second. Therefore a message from the toes to the brain would require one-twentieth of a second, and the return message the same length of time; so if the feet were hurt, it

could not report the injury to the general office and receive a message in response until at least one-tenth of a second had passed.

Perhaps you have sometimes thought you would like to be a telegraph operator, and here you have been one all your life but didn't know it. More than that, you not only operate, but you own the whole line. Some of the messages which you send or receive you forget at once, and some you file and put away in another part of the brain, which we will study as the library.

I watched the head clerk in the office of a hotel the other day; he received the travelers who came, had them register their names, assigned them rooms, and sent their baggage up after them. He ordered the call boys to answer the bells, he heard complaints, made out the bills, took in the money, and received telegrams. He quieted an angry man, and stirred up a lazy boy. He was thinking of everything; controlling and managing everything; and I said, "How much this is like Man in his great central brain-office. He sends and receives messages; he registers guests; he thinks, plans, orders, executes; and what is strangest of all, he perhaps does not know that he is doing anything at all remarkable.

CHAPTER XXI.

THE WONDERFUL CLOCK.

IN the great World's Fair at Vienna, Austria, in 1873, I saw a clock that would run ten years without winding. It marked the seconds, minutes, and hours; the day, week, and month; the year and changes of the moon, and I cannot tell you how many other things besides. I thought that this was the most wonderful clock I had ever heard of, but yesterday I heard of a clock that runs by electricity and regulates and winds itself; and, now that I come to think of it, I see that this is only patterning after the marvelous clock of our wonderful house. This is wound up at the beginning of life, and runs on till life's close, kept in motion and regulated by the electric nerve force.

Its measures of time are not the same as we have in our watches, and each individual house has its own time. The generality of mankind keep nearly the same bodily time, and that has created what we may call a standard time; but each individual may vary from the standard and yet be all right. This wonderful clock we call the sympathetic

nervous system. We have seen that the cerebro-spinal nervous system governs voluntary muscles. The sympathetic nerves govern involuntary muscles, and these are located inside the body. This nervous system is made up of ganglia, about fifty in number, located in the cavity of the body on each side of the spinal column. They are united by nerve fibers passing from one to the other; some fibers also pass to the spinal nerves, so that the two systems are in a way connected. The fibers from these ganglia form networks in various parts of the cavities of the body, and each network is called a *plexus*. The great plexus, which lies in the abdominal cavity, is sometimes spoken of as the abdominal brain. The cranial brain is the seat of consciousness and thought. The abdominal brain presides over the functions of the organs of the body. It takes charge of secretion; it controls and manages nourishment; it receives sensations and transmits motions without consulting the head clerk in the central office; it controls the size and tone of the blood vessels; it sends orders to the liver, causing it to manufacture bile and glycogen, and excrete urea. It may send such violent orders to the intestines that, in their haste to obey, they contract with so much force as to cause pain or a very rapid action of the bowels. If this abdominal brain gets excited, it may order

the sweat glands to pour out such a quantity of water that the person is bathed in perspiration. This brain we call the *solar plexus*.

The different ganglia of the sympathetic nervous

SYMPATHETIC NERVE OF THE ABDOMEN.

system may each be called a little brain. These ganglia are found everywhere in the viscera and are known as automatic motor centers. Those located in the heart cause it to beat,

"Keeping time, time. time,
In a sort of Runic rhyme,"

not in unison with the passing seconds, but a little faster, about seventy-two times in a minute.

In the intestines the automatic motor ganglia keep up a rhythmic motion which we call *peristalsis*, moving the contents along. The lungs have their rhythm, filling and emptying eighteen or twenty times a minute. Dr. Byron Robinson says the liver has also a rhythm, enlarging with influx of blood during digestion, and returning to normal size during rest. He finds that the spleen works according to rythmic time in the same way as the liver, and so do the pancreas and kidneys.

Is not this a wonderful clock that marks off the functions of the body in regular beats, some fast, some slow, some oftener than once a second, some not oftener than once a month? And as this is not under the control of our will, we must think that the divine Architect himself made it, wound it up, set it in motion, and governs it by his own power.

O wonderful clock of our earthly life,
  That beats from our birth to death,
That marks the pulsing of our hearts,
  The flowing of our breath:
God holds the key in His own right hand
  And watches thy pendulum swing;
He turns the hands as the pulses beat,
  Himself holds the strong mainspring;
And our life shall beat at His royal word,
  And shall end as His will shall be;
But the life of the soul shall pulse on and on
  Throughout eternity.

CHAPTER XXII.

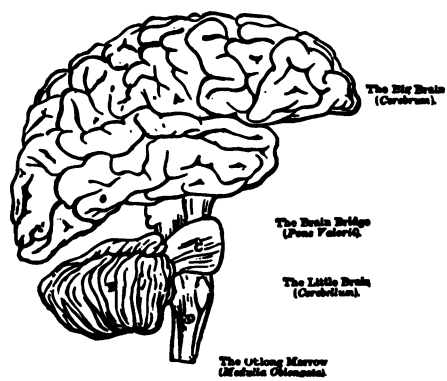
REGULATOR AND MAINSPRING.

IF you open your watch so that you can look at the works, you will see a little pointer that moves along the scale of an arc, at the end of which is the letter F, which stands for fast; at the other end the letter S, for slow. By moving this pointer towards one or the other, the watch is made to run faster or slower.

Our wonderful clock has a regulator located in the back part of the general office. It is called the *cerebellum*, or little brain. Like the cerebrum, or great brain, it is composed of white and gray matter, and the two divisions of the brain are connected by the *Pons Varolii*. We can move the regulators of our watches back and forth and yet really have no idea how any change is effected. And I am compelled to tell you that we are as yet somewhat ignorant of what the cerebellum does, but it is generally admitted that it controls, regulates,—co-ordinates, physiologists say,—the movements of voluntary muscles. Experiments prove that it is not an organ of thought, feeling,

or motion, like the great brain; but its importance is indicated by the fact that its convolutions are deeper, so that there is a greater proportion of gray matter, and that, we learned, is the important nerve substance.

When we cannot find out just what the healthy organ does, we study what effect is produced by



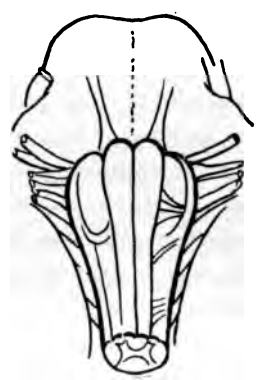
disease or injury of the organ. If the cerebellum is entirely removed from a pigeon, the bird dies. If only the superficial layer is removed, the bird becomes weak and its movements are not uniform. If a still greater part is taken away, the movements become more irregular and violent, the bird cannot fly or spring or walk perfectly. Its will is not affected, but it seems not to have the power of doing what it wants to do. When the deeper

layers of the cerebellum are removed, it cannot fly or turn or walk at all. If placed on its back, it cannot get upon its legs. It will try very hard to do the things it has been accustomed to do, but all to no purpose. The limbs move, but anyhow and everyhow. It can see and hear; it has intelligence; it tries to avoid obstacles; but all its efforts are ineffectual; apparently because it cannot regulate its movements and make its muscles work together.

When we remember how many muscles may be used in making single, simple movements, we can understand that there must be some power that will regulate the nerve force sent to those muscles, so that they will work in harmony without our thinking about it. For instance, it takes six particular movements and calls into play a dozen or more muscles, to take one step in walking. It would be impossible for us to manage all that machinery by the will, to send the various messages to just the right point to flex the leg, move it forward, straighten the knee, lift the heel, rest on the toe, bring the other leg forward, and repeat those at every step. We learn to do this very slowly, carefully, and imperfectly, at first. See the baby learning to walk. He does not succeed in making all the muscles work harmoniously together, but after a time the muscles get

trained, the cerebellum takes control of the nerve force, and walking becomes automatic—that is, we will to walk, and after that, the muscles do it themselves. But, as we have seen by the experiments made on the pigeon, the muscles could not do it, no matter how much we willed it, if the cerebellum did not take charge of matters and act as a regulator.

And now we will talk of the mainspring, which is the name I give to the *medulla oblongata;* those two words mean the oblong marrow. We



MEDULLA OBLONGATA.

know how very important the mainspring of a watch is, or at least we find out when it is broken. Then the watch stops and will not go until a new mainspring is put in. Unfortunately for us, when

our bodily mainspring is broken, our wonderful clock stops forever; we can never get a new spring. For that reason, the center of the medulla oblongata is called the vital knot, for injury to that stops all the machinery, and Man suddenly moves out of his bodily dwelling to live in it no more.

The medulla oblongata is composed of white and gray matter, and is rather pyramidal in shape, the base being upward. It really may be called an enlargement of the spinal cord. It is about an inch and a quarter long, three fourths of an inch wide, and half an inch thick; so you see that it does not require a very big space to contain the vital knot. You will be able to judge of its location, by remembering that it unites the brain and spinal cord. In the medulla, a part of the nerve fibers of one side of the brain cross over to govern the other side of the body; some of them cross in the cord itself, and some in the pons varolii.

The books say that the medulla is the center of reflex influences, and I think we have said nothing about these. When I told you how long it takes for a message to go from an injured foot to the brain and the return message to be sent, you perhaps thought it certainly could not take so long, for, if your hand or foot were hurt, you jerked it away before you thought. That was

true, but it was not because the message traveled faster than I said, but because there are in the spinal cord and in the medulla, some nerve centers that do not wait for commands from the brain before they send messages over the motor nerves to the muscles. The messages from the injured part reach some of these nerve centers, perhaps in the spinal cord, and they send the messages to take the hand or foot away, and it is really done before the brain has received word that any harm is threatened.

The movements resulting from these reflex influences we call reflex movements, and certain of them originate in the nerve centers of the medulla. Sudden winking to protect the eye from injury is controlled by the medulla, and is a reflex act. Sneezing is also a reflex act; we cannot produce a real sneeze at will, but if something irritates the mucous membrane of the nose, a message to that effect is sent to the brain, and on its way passes through the medulla. The reflex nerve centers there located send back word to the muscles of expiration to put the offender out, even though we should be in church or in some very solemn place. Coughing, swallowing, and vomiting, are all reflex acts governed by the nerves of the medulla.

The cerebro-spinal and the sympathetic nervous

systems are closely united, so, by the action of the cerebro-spinal nerves, we can, by our wills, govern some things to a certain point. Then the sympathetic system takes control, and our will is set aside. This is the case with breathing. The lungs are mechanically self-adjusting through the nerve centers of the medulla and breathing is really a reflex act. Taking in the breath stimulates the fibers which act reflexly on the nerve centers governing the breathing out; and lessening the size of the lungs in breathing out acts reflexly on the nerves which govern the breathing-in muscles, and so the lungs keep continually at work.

Is it not marvelous that so small an organ as the medulla oblongata can have such a wonderful controlling power over the various organs of the body, keeping them moving in time and tune so that there will be no discord in the song of life?

CHAPTER XXIII.

SPECIAL WATCHMEN.

WHEN a man owns an elegant mansion, he is often not satisfied with the guard kept over it by the regular police, but employs special watchmen. Our bodily house has five such watchmen, called special senses, named: Sight, Hearing, Smell, Taste and Touch. We have already studied these under other titles; we must now learn how they are special guards protecting us from danger.

Sight dwells in the eye, and we can readily see how he is a protection. If you have ever seen a blind man walking alone through the streets of a city, you have been impressed by the dangers with which he is surrounded: the people, the gutters, the street-crossings, the teams, the open cellar-doors, and the lamp-posts are all possible causes of injury which he can avoid only by carefully feeling his way with his cane; but you, with your quick, keen eyes, can run through the crowded thoroughfares, avoiding the open doors, dodging the teams, jumping over the gutters, and

go four blocks while he is warily picking his way across one.

The special nerve of sight is the Optic nerve.

Hearing is also a great protection against dangers which come from places where man cannot see. These messages pass over the Auditory nerve. If danger is approaching from the rear, man may be warned by his ears. It is not quite as unsafe for the deaf man to go about alone as it is for the blind man, and yet he is in great danger. He does not hear the runaway horses that are dashing upon him, or the whistle of the train, or the bell of the electric street-car, and so may be killed even though he has the sense of sight. People sometimes ask each other whether they would rather be blind or deaf. Each condition has its inconveniences and perils, and each its compensations. The blind man cannot see his friends; cannot read the ordinary printed page; cannot enjoy the sunset or landscape; but he can hear the voices of people and the songs of birds; can listen to the lecture or the concert, even though it be in darkness; and with his fingers, by the aid of his friend Touch, can learn to read the raised printing made especially for the blind. The deaf man can see all the beauties of nature and art; can walk unattended; can read books and papers; but cannot hear. Did you ever

think what it would be to live in a world without sound; to see life in all its activities pass like a panorama before you; to see people laugh, and not know what they are laughing at; to see people talk, and not know what they are talking about? It must be a great trial and I wonder at the patience of the deaf people, and feel that we have not half the sympathy with them that we should have.

TONGUE.

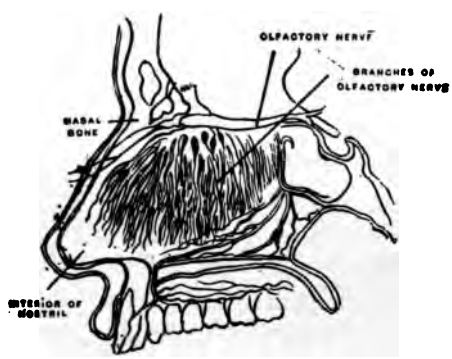
We learned of Taste when we were introduced to him as the guard in a pink sentry box stationed in the reception room. His position is one of

great responsibility, but he is not always to be entirely relied upon. He can be taught to be very fond of hurtful things and to admit into the house guests that are determined to do great injury. The electric wire connecting the sentry box with the general office is called the Gustatory nerve. On the tongue are little points called *papillae*, in which Taste especially dwells. Objects to be tasted must be dissolved either in water or in the fluids of the mouth.

It is rather queer that some things taste different on the tip of the tongue from what they do on the back of the tongue; for example: alum tastes sour on the tip and sweet on the back of the tongue; sulphate of sodium tastes salty on the tip and bitter on the back. If Taste were left to his own uneducated sense, it is quite doubtful if he would ever admit to the house any very salty, fiery or bitter visitors; but if often introduced to them, he after a time begins to tolerate them and ends by liking them, and then his judgment as a guard is impaired. It should be our aim to allow him to become acquainted only with those who visit us with motives of helpfulness, and of these we shall speak when we interview the guests of Man in his bodily house.

Smell, another special watchman, resides in the porch of the nose, in the lining, which, as we

learned, is called the Schneiderian membrane. He can be trained to great acuteness, or he can be very dull and unreliable. In the savage, the source of smell becomes a great source of information, as it is in many animals. Humboldt says that certain South American Indians can smell a stranger in the dark, and tell whether he is white or black. It is very important that a cook should



have the keen sense of smell in order to judge of the quality and condition of foods, and also to know whether things on the stove are burning.

The special nerve of smell is called the Olfactory nerve. When irritating substances are taken into the nose, its nerves of sensation are aroused, and they report to the general office; orders are given and the offender is sent out with a noise we

call sneezing, so that these nerves of sensation are also special watchmen. The sense of smell gives us enjoyment as well as protection. It delights in the odor of flowers and perfumes, and the pleasure of eating is increased by the odor of food

One special purpose of smell is to warn us against bad air. Does our good fairy Aura ever get naughty? Aura is quite like people; she becomes bad by keeping bad company. As long as she is associated with good company she brings only pure and enjoyable odors to the sense of smell; but when she mingles with disreputable members of the Gas family, she brings to the house some guests that make Smell feel inclined to shut the door in her face; and if he makes a loud enough complaint to the central office, Man hears and sets matters right by moving his quarters, or by sending Aura's bad companions where they cannot come into the house. If man pays no attention to the complaint, Smell gets tired of grumbling, and Aura may take with her into the laundry a good many guests who themselves badly need washing, and we have no arrangements for washing outside tramps; the laundry is arranged only for the purpose of attending to the members of our own household, so it is quite important that we heed the first warning of Smell

when he reports that Aura is coming in with undesirable visitors.

The last of our special watchmen is Touch, and he resides in what are called the tactile corpuscles of the nerves of sensation. How much our physiologists delight in big words! But I don't begin to tell you half the long words they use, for I don't want to frighten you away from the study of your wonderful house.

You remember that the nerves of sensation carry messages from the outside of the body to the brain. By them we learn the form of substances, their hardness, smoothness, and temperature. If the nerves are unpleasantly impressed at any time, they report at once to Man, and so warn him of danger, and this warning we call pain. Thus we see that Pain, instead of being an enemy, is one of our best friends, and whenever we feel pain, we should remember that it is a kindly warning. Some people act as if Pain were a foe who must be silenced at any cost, so they do all they possibly can to make him keep still. The wiser plan is to learn, if possible, what it is that makes him cry out and then remove the cause. If it were not for Pain warning us of danger, we might be so seriously injured before we knew what was being done, that there would be no way to cure the injury. It seems hard that the dear little

baby should be hurt when he falls, or burned by the fire, or cut by the knife; but by these methods Pain is teaching him to be careful, and to guard himself against danger.

Some physiologists tell us of a muscular sense which, they say, indicates the condition of the muscles themselves; judges of weight of objects and the amount of power needed to overcome the resistance; enables us to walk straight with our eyes shut or to carry parcels in our arms without dropping them.

Other authors claim that all this is obtained through the brain and not through any special sense located in the muscles.

While they are discussing and disagreeing, we will go on lifting weights, counting coins, carrying bundles, running and walking with our eyes open or shut, just as if we were absolutely certain whether it is muscular sense or brain power that enables us to do all these things.

CHAPTER XXIV.

THE WINDOWS.

WE might expect that a building so important as our marvelous mansion would have many windows. In fact, it has only two, but these are worthy of our admiration. Over them are hung beautiful awnings trimmed with a fringe corresponding in color to that of the house itself. The divine Architect makes nothing for ornament only, and so this fringe acts as a guard to sweep away intruders. The awnings are lined with a delicate pink membrane, called the *conjunctiva*, which is reflected downward over the windows themselves as a netting or screen. These awnings also serve to wash the windows. They are raised and lowered noiselessly, by means of small muscles, at the will of the occupant. I said at the will of the occupant; but, in fact, they are being raised and lowered continually whether he thinks about it or not, and this is called winking. Close up under the eyelid is a little sac or *lachrymal gland* which secretes a fluid, and the winking spreads this fluid

over the surface of the eye. On the lower eyelid near the nose is the opening of a little canal through which the fluid passes downward into the nose; so the winking is, in reality, a washing of the windows. Would not our housekeepers think it a fine thing if some genius would invent an awning that would wash windows after this fashion? Sometimes the fluid accumulates so fast

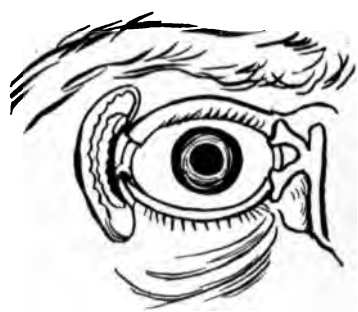


DIAGRAM OF EYE.
Showing lachrymal duct to the right.

that it cannot be disposed of through the canal, but overflows upon the cheek; this we call crying or shedding tears. Along the lower lid is a row of little oil glands, and the oily secretion keeps the lids from sticking together when they are shut; and as oil and water will not mix, it serves also to keep the tears from overflowing on the cheeks. When the awnings are raised, we can see

the beautiful transparent windows through which Man looks out upon the world. And when at night he is tired of looking, and draws the awnings down over the windows, we say he is asleep.

At each window hangs a circular curtain, colored in harmony with the tinting of the house, adding greatly to its beauty. In its center is a circular opening which looks to us like a round black spot in the center of the eye. There is a small muscle round this opening which has the power of contracting and making the hole small when the light is too strong, or relaxing and making the hole large if the light is too weak.

The transparent window in front of the curtain, in shape like the crystal of a watch, is called the *cornea*. The curtain is called the *iris*, which means rainbow.

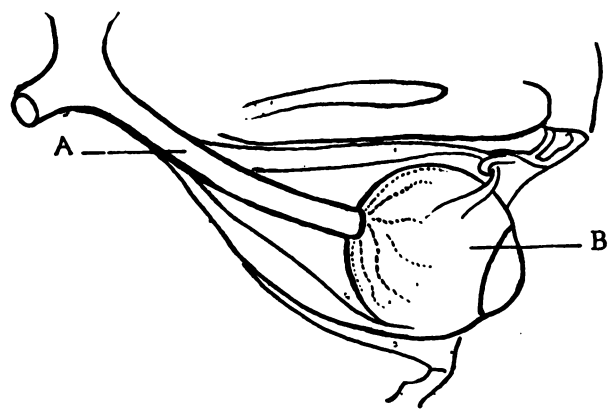
Through these rainbow-tinted windows Man becomes acquainted with all the beauties of Nature and Art, and through these windows we come most near to catching a glimpse of Man himself. If we can read the language of the eye, we shall know the thoughts. The lips may speak falsely but the eyes do not lie, and may contradict the spoken word. The lips may be silent, and the eye speak so eloquently of gratitude, affection, or confidence that words are needless. With the eyes closed, light dies out of the face. No wonder

that the faces of the blind are lacking in expression, while the face of a deaf-mute, who hears with his eyes, glows with the intensity of his own thoughts and with the reflection of the varying phases of life around him. We often hear of "the tell-tale eye," and when we are in doubt of the truth of a statement, we say, "Can you look me in the eye and say that?" I trust that we shall each keep a soul so pure and true that we shall always be able to look the world in the face with an open, honest glance from our soul-windows.

CHAPTER XXV.

THE PHOTOGRAPHIC CAMERA.

SO many people now-a-days are interested in the study of photography that you will be pleased to hear that the eye is a photographic camera. A photograph is made by using a plate



DIAGRAM, SHOWING LARGE NERVE OF THE EYE.
A, Optic nerve; *B*, Eyeball.

of glass covered with a film which is sensitive to light. This sensitive plate is placed in a box with a small opening through which the light enters. The object to be photographed is placed in front

of this box, or camera, as it is called, and the light reflected from the object, passing through the opening in the box, acts upon the sensitive plate and produces the image. The light parts of the object act strongly upon the plate, the dark parts, or shadows, act feebly, and thus a life-like image is obtained.

You see, if it were not for light and shade there

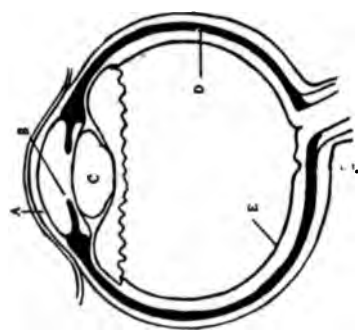
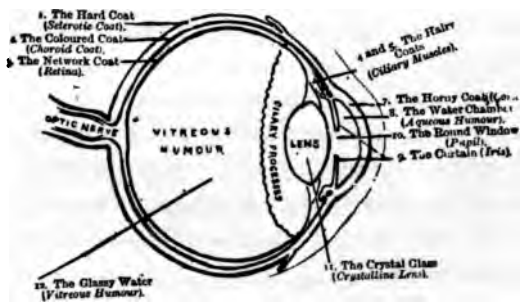


DIAGRAM OF THE EYE.

A, Cornea; *B*, Iris; *C*, Lens; *D*, Choroid or second coat; *E*, Retina.

could be no picture. I have read that Queen Elizabeth was very much offended with the artist who, in painting her portrait, made some parts of her face darker than others, saying that her face did not have such dark spots upon it, which shows that, highly educated as she was, she did not understand the necessity of shadows in a picture. It is very interesting to notice how closely the eye

in its structure resembles the photographer's camera. In shape the eyeball is nearly spherical. The interior is a soft, jelly-like, transparent substance called the *vitreous humor*, from the Latin word vitreous, glassy. This vitreous humor is, in shape, much like a rubber ball, dented in on one side. The dented place is just back of the iris, and in the space between the two is fitted the crystalline lens. The space in front of the iris,


1. The Hard Coat (Sclerotic Coat).
2. The Coloured Coat (Choroid Coat).
3. The Network Coat (Retina).
4 and 5. The Hairy Coats (Ciliary Muscles).
7. The Horny Coat (Cornea).
8. The Water Chamber (Aqueous Humour).
10. The Round Window (Pupil).
9. The Curtain (Iris).
OPTIC NERVE
VITREOUS HUMOUR
CILIARY PROCESSES
LENS
11. The Crystal Glass (Crystalline Lens).
12. The Glassy Water (Vitreous Humour).

between it and the cornea, is filled with a fluid known as the *aqueous* or watery humor.

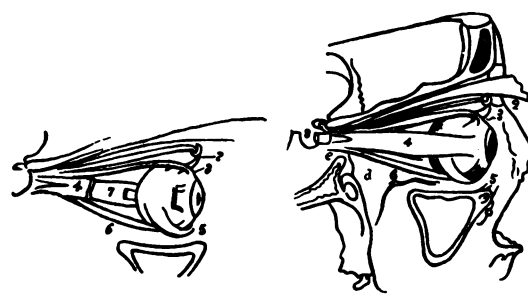
The vitreous humor is surrounded by a very delicate, transparent membrane, the *hyaloid*, which splits into two layers when it reaches the lens, enclosing its edges and holding it in place. Just outside of this comes a coat called the *retina*, from a Latin word meaning network, which covers two-thirds of the eyeball and ends in scalloped edges,

the *orra serrata*. This retina is the most important part of the eye, for it is really the organ of sight. Although it is extremely delicate, it is a very complicated structure, having no less than ten distinct layers of tubes, fibers, cells, and granular matter, all of which, no doubt, are very important, but which we cannot now fully discuss.

Outside of the retina is a covering called the *choroid* coat, from a Greek word meaning leather, because it is dark brown or almost black in color. This covers all of the eyeball except the part in front which is occupied with the transparent window, the cornea, of which I have told you. Outside of all is a strong membrane which is called the *sclerotic*, from a Greek word meaning hard, because it is the toughest coat of the eye. The sclerotic unites with the choroid coat around the edge of the cornea.

Do you think now you have a good idea of the eye? Take your rubber ball and dent it in on one side. In front of this dent place a watch crystal. Imagine that your ball has two coverings that unite around the edge of the crystal, holding it in place. Inside of these two coverings is the delicate network of the retina, and the ball itself represents the vitreous humor. The watch crystal represents the cornea. Back of this cornea stretch a colored curtain with a hole in the center, and

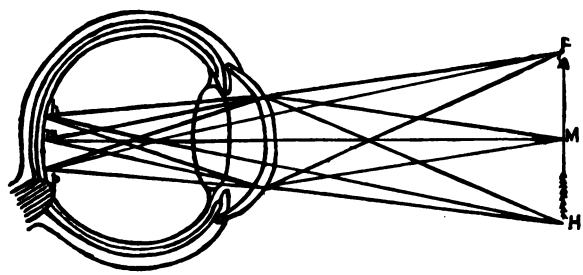
just back of this hole in the dented place of the ball, put a double convex lens, and you will have a very good representation of the eye. The eyeball thus completed is surrounded by a cushion of fat which fills the bony cavity of the socket of the eye so that it can turn easily without injury. To the eyeball are attached six muscles which enable it to be moved in all directions. One of them is of particular interest because it runs over a pulley.



MUSCLES OF EYE.

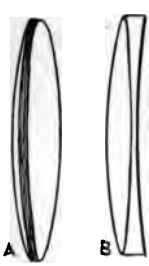
And now we will see how the eye and the camera compare with each other. The camera is a box with only one opening to admit light. We may say the same of the eye. The camera is painted a dull black inside; the eye has its dark choroid coat. In the opening in front of the camera is a brass tube fitted within a double convex lens and this tube is lengthened or shortened by means of a screw. The eye has its convex

lens which changes its shape instead of being moved forward and backward. No light can enter the camera except through the one opening, and it must pass through the lens to reach the sensi-



Showing how the Rays from an Object Focus on the Retina.

tive plate; no light can enter the eye except through the circular opening of the iris, and it must pass through the lens before it reaches the sensitive plate of the retina. In the camera the lens is altered in its position so as to bring the rays of light to a point or focus, as it is called, just at the right place. In the eye this is accomplished by changing the shape of the lens. A lens is a glass shaped so as to bend or refract the rays of light so that, entering the lens parallel, they will be changed in direction. A convex



LENSES.
A, Convex. *B*, Concave.

lens bends the rays so that they will all come together at one point, and the more convex the lens, the sooner will the rays of light come together.

In the eye, this bending of the rays of light is aided by the cornea and also by the aqueous and vitreous humors, as well as by the changing of the shape of the lens. The ciliary muscles which surround the lens contract and make it more convex, or relax and flatten it. The nearer the object, the more convex the lens becomes; the farther away the object, the more the lens flattens. This is called the power of accommodation of the eye, and its purpose is to focus the rays of light directly on the retina.

When we look at a photograph, if we see that the features are not clear and distinct, we say that the person was out of focus; by that we mean that he was not placed so that the rays of light reflected from him would come to a point just exactly on the sensitive plate, therefore the image is more or less blurred. The closest point at which an object can be distinctly seen is, in the normal eye, about six inches. This is called the near point of vision. When an object is brought nearer to the eye than this, the effort to increase the convexity of the lens so as to bring the rays of light to a focus sooner, becomes painful and the object is no longer distinctly seen.

Between the point of near vision and a distance of seventy or eighty inches from the eye, the lens must be changed or accommodated in order to perceive an object clearly. Beyond seventy or eighty inches the rays of light from objects enter the eye so nearly parallel that no change of lens is required, so we may say that the far point of vision is at an infinite distance.

The eye can change or accommodate from a near to a distant object more rapidly than from a distant to a near object, because this change is a flattening of the lens by a relaxation of the ciliary muscles, and they can relax more quickly than they can contract to make the lens more convex. If the eye is not normal, it may perhaps be too short from front to back, in which case the person is far-sighted; that is, the rays of light do not come together soon enough and so focus beyond the retina and the object will have to be moved farther away to be seen distinctly, or the defect can be remedied by wearing spectacles with a convex lens, which will help to focus the rays sooner. If the eyeball is too long from front to back, the rays come to a focus too soon and the image will be formed in front of the retina. In this case, the person moves the object closer so as to focus the rays on the retina. He is short-sighted, or near-sighted, and his glasses need to

be concave so as to slightly disperse the rays and keep them from coming to a focus too soon. But all the light in the world would not produce sight if there were not some arrangement for sending messages to the brain. Light strikes on the nerves of the retina, they communicate sensation to the optic nerve, and it carries them on to the brain, and man becomes aware of what is passing before his eyes. This optic nerve has not the power of receiving impressions of light; it can only tell what the retina reports. Where the optic nerve enters the eye there is no sight, and this is called the blind spot. The nerve enters the eye a little to one side, so this blind spot does not interfere with our vision. If you are doubtful about having a blind spot in your eye, you can prove it for

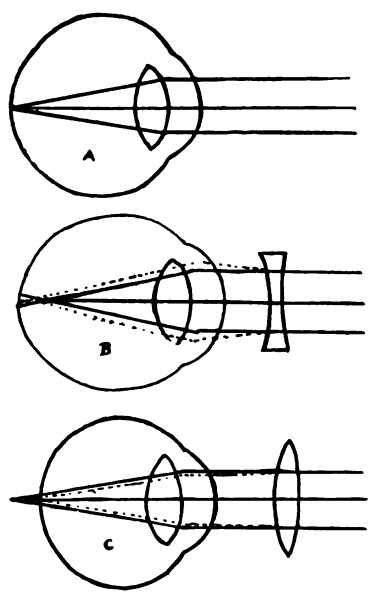


DIAGRAM SHOWING DIFFERENCE IN FOCUS.

yourself. Hold your two thumbs side by side before your eyes, about the distance you would hold a book in reading. Shut your left eye and fix your right eye on the nail of your left thumb. You are not making an effort now to see the right thumb but you still can see it. Now move the right thumb slowly away to one side and you will find there will be a spot where you cannot see the right thumb at all, although you can see the shut hand; but a little further on you will see the thumb again, though all this time you have been looking steadily at the left thumb.

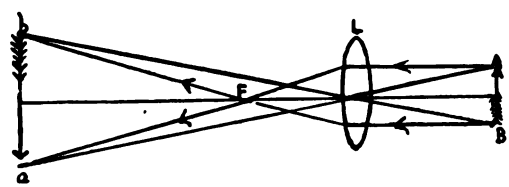
The most sensitive part of the retina is directly in the center of the back of the eye. Here is a yellow spot where there are no fibers of the optic nerve, and the cones of the retina are very numerous. In looking at large objects we move the eyes so the different parts of the object are one after another brought into line with this yellow spot, then the brain takes all the separate impressions and puts them together in one image, and judges of them as a whole; but we do this so quickly and so constantly that we do not realize that we are doing it. The rapid motion of the eyes in seeing, and our ability to notice only the vivid impressions, are the reasons why we are unconscious of our blind spot. I think it would be a good thing if we could turn our blind spot

toward the unpleasant things of life and not see them at all.

The stimulation of light upon the retina may last one-eighth of a second after the object which reflected the light is removed, and it remains visible for that length of time to the eye, although in reality not present; so two impressions may follow each other so quickly as to seem to be continuous. A wheel may revolve so rapidly that the spokes seem to blend and become a solid, or a string with something bright at the end may be whirled so fast that we seem to see a bright circle. I saw not long ago a little peep show, called a Zoetrope, which was made very interesting by understanding this fact. Looking through the peep-holes I saw a man apparently running and jumping into a barrel and out again, in and out, in and out, as if he really were alive. A horse jumped over a hurdle, a man ran up a ladder and into the open mouth of a giant that closed upon him. When the revolving wheel stood still, I saw that on a band of paper were pictures representing men and animals in the various positions of running and jumping, and when the wheel was set in rapid motion the effect of real life was produced.

We have learned that there are many things going on in the eye of which we are unconscious.

We do not realize that in vision we receive a multitude of impressions which the brain puts together in a complete whole. We are not conscious of changing the shape of the lens to bring the rays to a focus on the retina. We do not think anything about having a blind spot, and we are not practically aware of the fact that we see everything upside down. The accompanying figure will perhaps explain why:



You see the rays at *a* are bent by the lens and focus at A and those from *b* at B, and rays from every other point along the line from *a* to *b* are focused at corresponding points between A and B, so that we have a distinct image at the line A and B of the object *a* and *b*, but much smaller and inverted. You can hardly believe that you see everything upside down in this way, but that is what the scientists tell us, and they have proved it by their experiments; so I suppose we will have to believe them, while at the same time we are quite sure that we see things right side up.

It is quite impossible for us to realize how much of our perception of objects by sight is the result of education. I have just read of an individual born with a film over the eyes which was removed after he had grown to maturity. When he first looked at things, he thought they touched his eyes, and when he put his hand to his eye he was surprised at not finding the object there and that he had to walk, often some distance, before he could touch it. He was obliged to train his eyes by means of his other senses.

We are able to judge of the solidity of objects because we look at them with two eyes. The image formed in each eye is not exactly the same; we can see just a little further around on one side of the object with one eye than with the other, and when the brain puts these two images together, we get the idea of perspective. If you will look at an object first with one eye shut and then with the other, you see just how different the view taken by each eye is. You have seen a stereoscope? Well, it is made on the same principle as the eye. There are two pictures taken from a slightly different point of view and looked at through two lenses, separated by a partition so that the pictures blend into one. The eyes are lenses separated by the partition of the nose, and the two views which they see of an object are

blended together and give us the idea of form and solidity.

Why do not all objects seem of the same color? Ah, now you have asked an interesting question, and, although I may not be able to answer it fully, I hope you will continue to study the subject until you have learned all about it.

Sunlight seems white but is made by the union of seven colors. The three primary colors are red, blue and yellow, and these uniting make the seven, as we see them in the rainbow. Green is made of blue and yellow, orange of red and yellow; red and blue make violet, and violet and blue make indigo. Isaac Newton arranged these colors in the order of the rainbow on a disk, and rotating it with great rapidity saw that they blended and the disk looked of a dull white. If an object lets all the rays of light pass through it, it will have no color, and is called translucent. If it allows none of the rays to pass through it, but reflects or sends them all back to the eye, the object looks white. If it absorbs all and reflects none, it appears black. If it reflects only red rays, absorbing all the others, it looks red; and so with all the other primary colors. If it reflects some blue and some yellow rays, it looks green, and so on.

How does the retina then tell us the story as to

the reflection of light by the object, for the retina must be sensitive to all rays? It is supposed that certain nerve fibers are excited by certain colors; or to speak accurately, there are three sets of fibers affected by the three primary colors, and the way in which these fibers are affected will produce the various tints. If all are aroused, they produce a sensation of white; red will affect those fibers sensitive to red rays; green will arouse those sensitive to blue and yellow, and in this way the various combinations of colors are made known to us. This theory would account for color-blindness on the supposition that the fibers which should be sensitive to some certain color do not respond to that color.

Color adds much to the beauty of the world. Just think how gloomy it would be if everything were of a dull gray or brown! Even the most beautiful color impartially given to every object would become monotonous. Those who are color-blind lose much of the pleasure of sight, but the matter becomes of more serious import when we realize how the safety and life of people depend upon the power of the engineer or pilot to recognize the color of danger signals.

Color-blindness is much more common among men than women. One eminent oculist asserts that among twelve thousand children, he found

ten girls and four hundred and eighty boys who were color-blind; among a large audience of men and women, ten per cent of the men were color-blind but not one woman. Some physicians are inclined to attribute this prevalence of color-blindness among boys and men to the use of tobacco.

CHAPTER XXVI.

THE MUSIC-ROOM.

ON either side of the cupola are two very pretty porticoes which protect the entrance to a wonderful music-room where music is never made, but where it is heard. Our good fairy Aura is a fine musician, but while she sings in one room, her music is not heard there but in another, and Aura runs from one room to another carrying the tones through these porticoes of the external ear to the place where they can be heard.

The porticoes are convoluted and fluted in various ways that add to their beauty. But these curvings are not wholly for looks, for we are told that they all help Aura to find her way into the circular passages that lead inward. These passages are protected by hairy guards who, however, never interfere with Aura. She goes with step brisk or slow through the porticoes, along the passages, until she comes to a curtain stretched tightly across the way. There is no opening in it, and it will not move; so what can she do? Ah, Aura is a fairy, and she can be in

more than one place at a time. She is also on the other side of this curtain, which is called the tympanum, or drum-head.

How did she get through if there is no door in this immovable curtain? Perhaps you will remember that there are seven passages leading from the throat, and two of these lead into the ears; they are called the *Eustachian tubes.*

FIG. 41 — Section of the ear, showing the relative positions of the external, middle, and internal ear.

Through these Aura finds her way into the cavity that is known as the drum of the ear. If you shut your mouth tightly, and hold your nose, and then try to breathe out, you can feel her rush through these tubes into the middle ear. You all know how a drum is made, but do you know that a drum must have air on the inside or it will not sound? The membrane of the tympanum is the head of the drum. But a drum will make no

music unless some one pounds on it. Well, Aura knows that, and so she pounds with little blows that are called waves of air, and the tympanum vibrates, and this is the beginning of hearing, but it is only the beginning. The cavity into which the Eustachian tubes lead is called the middle ear, and here Aura has some queer playthings. One is a little hammer; another, an anvil; the third, a stirrup. The little hammer is suspended by tiny muscles so that one end touches the tympanum, the

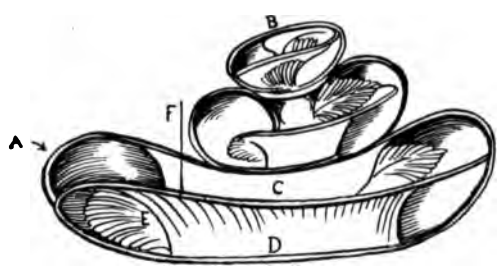
HAMMER. ANVIL. STIRRUP.

THE OSSEOUS LABYRINTH LAID OPEN. (Enlarged.)

other end touches the anvil; the anvil is connected to the stirrup, and the stirrup is fitted into

an oval window which is also closed by a tight membraneous curtain. The room on the other side of this window is very small and is called the vestibule. Out of this open three passages called semi-circular canals; they are tubes and are like loops. If you go out of the vestibule through one of these canals, you come into the vestibule again, and that would make six openings if it were not that two of them unite at one point and enter the vestibule by a common way.

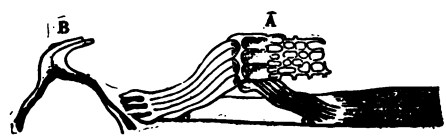
From the fore part of the vestibule passes another tube which coils two and a half times around like a snail shell, and so is called the



THE COCHLEA LAID OPEN.

cochlea. All of these tubes, forming what is called the labyrinth, are of bone, are lined by membranes, and filled with a fluid. In the vestibule are a number of six-sided crystals of carbonate of lime called *otoliths*, or bonestones, which vibrate in the fluid and strike against the hair-like

projections growing from the walls and seemingly connected with the nerve fibers. If we cut into the cochlea, we will see a central bony pillar around which the tube winds two and a half times, and is divided into three compartments, one called the staircase of the vestibule; one the staircase of the tympanum; and one the middle staircase. At the top of the staircase of the vestibule we pass through a small opening and go down the staircase of the tympanum to a round window. Do you understand that the floor of one staircase is the roof of the staircase below it, so the middle



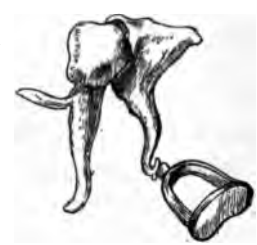
ARCHES OF ORGAN OF CORTI (VERY HIGHLY MAGNIFIED.)

one is roofed by the floor of the one above, and floored by the roof of the one below? This middle staircase is filled with a fluid, and in here is the *Organ of Corti*, a very complicated structure consisting of peculiarly shaped rods called the *rods of Corti* and of cells each connected with a nerve fiber at one end and with stiff hairs projecting from the other.

These all rest upon a basilar membrane composed of parallel fibers of different lengths. There are about twenty-four thousand of these fibers

and they vibrate as do the wires of a piano. It is presumed that the vibrations are stopped by the pressure of a membrane that lies over the rods of Corti and the stiff hairs.

When Aura enters the passage of the external ear, she goes on until she reaches the tympanum. Then she strikes it with many blows that make it shake. This motion is conducted through the hammer to the anvil, and on to the stirrup, which, pressing against the curtain in the oval window, makes that vibrate. That shakes the fluid in the vestibule, and this motion vibrates the membranes and fluids of the cochlea, and the different rates of vibration of the fluids in the middle staircase set in motion the corresponding fibers of the basilar membrane. This motion is communicated to the cells of the Organ of Corti, and they touch the nerve fibers and cause messages to be sent to Man in the general office of the brain.



The Hammer, Anvil and Stirrup in position.

But if all this is needed to perceive sound at all, we do not yet understand how we can distinguish such a multitude of sounds one from the other. The song of the canary does not sound like that of the nightingale, the buzz of the fly

is not like that of the mosquito. We learn to know the voices of different people, we distinguish high tones from low tones, loud sounds from soft ones. We know the sound of the wind, the sea, the tones of the piano or violin, the cry of pain or the laugh of joy. Can we explain all this? Perhaps not fully, yet we can tell something about it. If we take two tuning forks, both sounding the same note, and set them up some distance from each other, and strike one, we shall soon hear that the other is singing too; this is called sympathetic vibration. Perhaps you thought it was only live folks that sympathize. You know when you see any one laugh, you want to laugh; if they cry, you feel like crying; but here are two pieces of metal, and when one sings, the other begins to sing: that is, if they are both tuned to the same note; if they are not, then one may sing all it pleases and the other will be silent.

The explanation is this. Each sound makes its own vibration of air. It is like dropping a stone into the water and starting the little circles of waves in motion. Any impulse given to the air makes little waves which travel on and on. The waves made by striking the one tuning fork went on till they struck the other one, and as that fork was of the same key, it responded. If we should put up a great number of these tuning forks,

all tuned to different keys, and a tune was played in the room on any musical instrument, each fork would answer when its key-note was struck, just as if its name had been called, and one could tell just what notes had been sounded by seeing which forks were vibrating. If our supply of tuning forks was so great that we had one for every sound that could be made, each sound would set some one of them in motion. That is just what we suppose we have in the ear in this wonderful organ of Corti. Do you wonder that I call the ear a music room? If each fiber of the basilar membrane is sensitive to a particular vibration, and communicates that vibration to a nerve-fiber, then we hear the sound that corresponds to it.

If in a given time the vibrations are few in number they produce low tones; if many, they produce high tones. According to Peyer, twenty-three vibrations per second are the lowest we can hear, and 40,260 vibrations per second, the highest. This makes a range of about eleven and a half octaves.

The ear may be educated to analyze sounds. The skilled physician listening to the beating of the heart can detect sounds that would wholly escape the untrained ear, and the musician can hear the notes that make harmony of music where the uneducated ear hears but the prominent notes that form the melody.

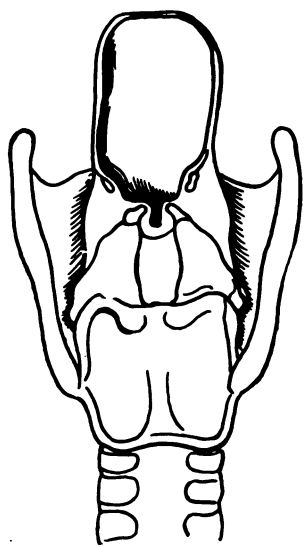
CHAPTER XXVII.

THE ORCHESTRION.

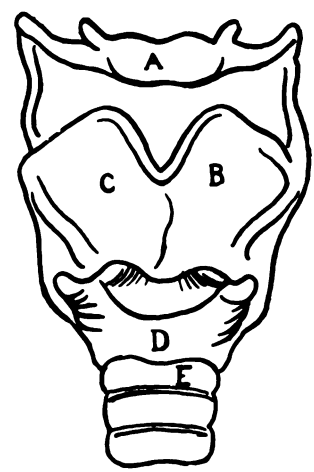
THE Standard Dictionary defines an orchestrion as a musical instrument designed to imitate the orchestra, and I think we have such an instrument in our wonderful house. Unlike the complicated organ of hearing, it is very simple in construction, although capable of making a marvelous variety of sounds. It can talk and sing, it can laugh and cry, it can mew like a cat and bark like a dog, crow like a rooster, neigh like a horse, and trill like a bird.

Did you ever see one of those strolling musicians who tries to be a whole band in himself? He has a bag-pipe under his arm, cymbals attached to his knees, a drum strapped on his back, and I don't know what other instruments fastened to him elsewhere, and he manages to strike each one of them once in a while. Of course, he has to stay in one place while playing, and there is very little music in it after all. It is only a very poor imitation of what we are constantly doing with our orchestrion without thinking that we are doing anything wonderful.

In the first place, we do not have a lot of instruments hung clumsily about us in various places, but our orchestrion is a compact little box that we carry in our throats. We are not obliged to stand still when we use it; we can walk, run or work while talking or singing.



LARYNX



FRONT VIEW OF THE LARYNX.

A, hyoid bone; *B*, *C*, thyroid cartilage; *D*, cricoid; *E*, first cartilaginous ring of the trachea.

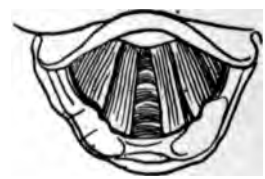
Our musical instrument is located at the top of the laundry stairs, and is called the *larynx* or voice-box. Aura comes through the voice-box every time we breathe, but she comes softly unless Man wants to use his musical instrument in some

way, and then she is ready to play it for him, and without her he could make no audible music.

The larynx is a cartilaginous box, without top or bottom, set at the top of the *trachea*. The little trap-door of the epiglottis shuts down over it when food is passing, but lifts to admit air. If you look at the picture of the larynx, you will see that the greater part of it is made of two large cartilages called *thyroid*, which means shield. At the top of each shield we see two little horns to which muscles are attached to suspend the larynx from the hyoid bone, which is the bone of the tongue. You didn't know you had a bone in your tongue? Well, it does not go through its length, but supports it at the roots, and also holds up the larynx. Below the thyroid is a cartilage called the *cricoid*, shaped like a signet ring: that is what cricoid means. On the upper edge of the cricoid at the back are two triangular cartilages called *arytenoid*, which play a very important part in the production of sound. These cartilages have muscles at each corner and are moved by them in much the same way that the triangular metal used in the old-fashioned bell-pull is worked.

Two bands of fibrous tissue are stretched across the larynx from front to back, leaving a chink between, and these are the vocal cords. When

the air is forced through this chink, it makes the cords vibrate, and sound is produced. In ordinary breathing, the cords are relaxed so sound is not made. This orchestrion is like a reed instrument. The vocal cords are like reeds: the lungs are the bellows, and the trachea is a pipe leading from the bellows to the voice-box. How simple is the construction, yet how complicated the powers of this unique instrument! Sound, as we have learned, is made by vibrations of air. If these vibrations are irregular, they constitute noise; if they have a certain regularity they make music. A high note has very quick vibrations; a low note, slow vibrations. Generally, instruments making the same note have different qualities of tone, because of what is called the overtones of each.



VOCAL ORGANS.

Loudness of tone is produced by the force with which air is sent out through the larynx. The cords are made longer or shorter by the action of the triangular cartilages. This determines the pitch of the tone. The shorter and tighter the cords, the faster the vibration and the higher the note; the longer and looser the cords, the slower the vibrations and the lower the note. At about

fourteen years of age the larynx enlarges, and the voice changes, becoming lower in tone. Voices of women are higher than those of men partly because the vocal cords are shorter. Children's are shorter still, and their voices are correspondingly higher.

The quality of the voice is affected by the shape of the throat, larynx, and the trachea, and also by the knowledge of how to use these organs. One can cultivate the habit of talking in a high and disagreeable voice, or in one that is low and soft. The poet says, "A low voice is an excellent thing in woman," and I think he might have said in everybody. The voice marks to a very great degree the cultivation of the individual, and also tells much about his character. The high voice is irritating and often betokens irritation. People scold in a high voice, and I think I am safe in saying that to be scolded never makes a person want to do better. The low voice tells more of deep feeling, and appeals to the better nature.

If you want to move one to good impulses, speak low and soft.

Having in our possession such a magnificent musical instrument, we should learn how to use it, not only in singing but in speaking and reading aloud, using tones that soothe and comfort rather than those that irritate and offend.

The hard palate and nasal passages form a sort of sounding board, and by their vibrations increase the resonance of tones. We say a man talks through his nose when, in fact, that is just what he does not do. The so-called nasal tone is made because the nasal passages are closed. The range of the human voice is about four octaves: that is, from the lowest note of a base voice to the highest note of a soprano. It is seldom that an individual can sing over a range of more than two and a half octaves.

We have only spoken of the production of musical tones. We would like to know something of the formation of speech, and we find that the tongue, lips, cheeks, palate, and pillars of the throat are all used in making vocal sounds, or in modifying the vibrations of air in various ways so as to produce peculiar sounds which we recognize as vowels or consonants, and the union of these form words. In spoken words we do not greatly vary the pitch, though we do not talk altogether on one tone; while in singing we vary the pitch of tones as well as their length, and give them with a rythm, which we call time: that is, the vibrations are repeated in a certain order which is pleasing to the ear.

Sometimes, we find a bodily house in which the orchestrion is silent. The individual is mute. We

used to think that was because he had no power to speak. We know now that it is because the organ of Corti in the inner ear will not respond to Aura when she plays on the drum of the ear. The person is deaf, we say, and, as he hears no sounds, he makes no attempt to imitate sounds with his vocal organs. He is mute merely because he is deaf. Formerly, the child born deaf was only taught to talk with his fingers, but now he is tanght to talk even though he cannot hear. If he can see, he can learn to read the motions of the lips. If he cannot see, he can learn to read the movements of the lips and larynx with his fingers. Have you not read of Helen Keller, the girl who cannot hear or see, and yet has learned to talk and hear through her fingers by putting them on the lips and throat of those who are talking to her? She is a bright, happy, well-educated girl in spite of her affliction, and we who can hear and see and speak, ought to thank the divine Architect both with heart and voice.

CHAPTER XXVIII.

THE LIBRARY.

DON'T you just enjoy a stormy winter day? The wind may howl, the sleet tap on the window-pane with its icy fingers, but it doesn't frighten us, for the fire glows cheerily, the big chair beckons us invitingly, and all around the walls of the library are books, books, books, waiting to be read: books of travel, of history, of poetry, of romance; the brightest, wittiest, most entrancing thoughts of the great minds of all ages; yours just for the looking at them. What could be more enjoyable? But perhaps your books are not many, only a few dear friends that a slim purse has allowed you to gather around you. They are in plain bindings on a simple pine shelf, but how you love them! They begin back with the friends of your childhood: dear Dotty Dimple and Prudy Parlin, Robinson Crusoe, Little Lord Fauntleroy, and all the sweet familiar faces that have not been displaced by the older friends, loved just as dearly: Paul Dombey, Little Dorrit, Tom Brown, Robert Falconer, Lorna Doone, Sir

Gibbie, and a host of others. How you love the familiar bindings even, and you take them up and caress them as if they knew how dear they were to you, and to part with one of them nearly breaks your heart. You cannot take your books as you go about your work or play, and yet, do you not have them with you? Ah, yes, you have stored them away in the library of your wonderful house, a company of dear friends who will ever be with you. You began this library far back in your childhood; and if you have been wise in the selection of your authors, you have now quite a collection of literature that you can enjoy at any time or place or at any hour of the day or night.

Perhaps you have not appreciated this library of yours. When you come to glance over its contents, you see only a higgledy-piggledy collection of scraps. There's an arithmetic with part of the multiplication table left out, and — O dear! what a state fractions is in! There's a grammar with only a few leaves in it, and they are filled with a collection of words which you don't understand; and the geography! why, in it, the Nile and Niger unite to form the Ohio; New York has moved over in the State of Rhode Island, and you could not find Abyssinia if you tried all day. The most complete collection of poems is "Mother Goose's Melodies," and there are just a few broken

and disconnected verses from the Bible. Oh, my dear, you really must begin to get things into better shape. What is this big bundle in the corner? Dime novels? I wish you could just take them all out and burn them up. They occupy so much space that ought to be filled with other things. It is one disadvantage of this library that you keep its contents even if you give them away, and the harder you try to forget them, the surer you are to remember them. There is one thing you can do, you can crowd them out. If from this time on you read no more foolish stories, but read good books, interesting and valuable books, gradually this pile of nonsense will fade away and grow dim, and in time, I hope, will vanish altogether.

Now let us see what else you have collected in your wonderful library. Where is your dictionary? Oh, it's rather small, is n't it? And now I look it over I find it contains a good many rather queer words, and the spelling seems to be a little unreliable; and here, on this page where you don't want me to look, are words that make me very sad to see. Let us fasten those leaves together and never peep at those words again. How many good, honest words do you suppose your dictionary contains? Not very many. Some people go through life with a vocabulary of only about three

hundred words. Your vocabulary means the words which you understand and use correctly.

LIMITED VOCABULARY.

Professor Max Müller quotes the statement of a clergyman that some of the people in his parish had not three hundred words in their vocabulary. A well-educated person seldom uses more than three thousand or four thousand words in actual conversation. Accurate thinkers and close reasoners, who select with great nicety the words that exactly fit their meaning, employ a much larger stock, and eloquent speakers may rise to the command of ten thousand words. Shakespeare, who displayed a greater variety of expressions than probably any other writer in any language, produced all his plays with about fifteen thousand words. Milton's works are built up with eight thousand, and the Old Testament says all it has to say with 5,642 different words.

If you should learn a new word and its meaning every day for a year, your vocabulary would begin to grow very rapidly, would n't it? What would be the use of so many words? They enable us to express different shades of meaning. No two words mean just exactly the same thing. I have heard of a young lady who had only two phrases with which to express her admiration, or her detestation. The things that she admired were "simply perfect," the ones she disliked were "perfectly simple."

If you like something very much, you probably say it is "perfectly lovely," or "awfully nice," and it does not matter whether it is a sermon, a

picture, a person, a dinner, or the weather. We like to be rich in money, why not like to be rich in words? Then we should be able to apply our adjectives more appropriately. People sometimes make a very ridiculous use of words. I have heard them talk of "beautiful oysters," an "elegant prayer-meeting," or a "handsome piece of music."

They had a vocabulary, but they had not studied definitions.

The library of our bodily house will differ in different people. In some, there are great quantities of mathematics; in some, the sciences predominate; in some, there are books in French, German, Latin, English, and perhaps half a dozen other languages. Some libraries have many poems, in others there will be scarcely a ryhme. Day by day this library should increase its stores.

There are people who seem to see and learn much, yet never store anything away; "they can't remember," they say. You have already understood that this library is the memory, and the brain is the organ of memory. We have not yet learned just in what parts of the brain different memories are located, though we know where lies the memory of spoken and written words. But we have learned what is of greater value, that even if we do not know just where the book-

shelves are that contain our memory library, we can find the different books when we want them, and, better still, we can constantly increase their number. This power of adding to the treasures of memory can be greatly cultivated. We can have good memories or poor ones, in just the same way that we can have strong muscles or weak ones; and that is by exercise or lack of exercise. Do you not think it would be a fine thing to be able to remember all the valuable facts with which we have become acquainted? How can you begin this power? First, you must take into account the fact that the material brain is the organ of thought, and to do good work it must have good food, the kind of food that will keep it in repair. Not only must nutrition be supplied through food, but it must be carried to the brain by a good circulation. To insure a good circulation, the heart must be vigorous—failure of heart-power is accompanied by failure of memory, and heart-power is increased by exercise. Then the brain must be exercised. It will not retain impressions unless it is trained to do so; but it must not be overworked. Fatigue, either of body or brain, lessens the power to remember. G. J. Holyoke says of his experience in this line, that when traveling expenses were the only pay he received for his lectures, he used to walk to save

railroad fare, and would be so weary in the evening that both voice and memory were weakened, and he did not find out for some years that it was bodily fatigue that had exhausted his power of speech, thought and memory. Nearly every grown person knows that when very weary he cannot remember even the things he knows best. Exhaustive exercise, then, should not be taken just before we need to use our brain.

Sickness weakens the memory, and various drugs, taken to promote sleep, may quite destroy the power of the brain to remember. Age weakens the memory because of failure of nutrition through diminished blood supply. H. L. Holbrook, in his little book on Memory, claims that old people can restore memory by persistently exercising it. His plan is to give everything close attention; to recall at night the experiences of the day, to remember the pages of a book whereon an interesting fact is recorded, to commit the names of public men, to learn poetry or the Bible; and he claims that this plan will restore the failing memory of the old. A wiser plan is never to let the memory fail, knowing that to use the brain, to intrust facts to it, to compel it to store up words, names, and incidents will keep it strong and reliable, and make of it a never failing source of wondrous pleasure both to one's self and to others.

Each sense has its own memory. We remember sounds, sights, colors, sensations, and flavors; and if two or more senses are united in retaining the impression, the more distinct it will be. If, for example, we want to gain a clear idea of a new fruit so as to remember and describe it perfectly, we can do it better if we handle it, look at it, smell of it, and taste it, than if we only see it, or if we only taste it without seeing.

Here are a few simple rules for improving or strengthening the memory. First: Never try to learn too much at a time. You will commit a poem faster by learning one line at a time and four lines a day, than you will by attempting to commit the whole poem at once. Second: Understand what you are trying to learn; if you don't understand, it becomes a collection of words without value. Third: Learn something every day, be it ever so little. Let the brain understand that it must work continually in the storing away of memories. Fourth: Go over your memory lessons often, and, if possible, at regular times, to see if you remember them. Fifth: Arrange facts to be remembered in an order that seems naturally to connect them, so that, if possible, one will suggest the other. Sixth: In quoting, be careful to use the exact words of the author so as to learn with precision and exactness of memory. Seventh: Make abstracts of

things desired to be remembered. To write them down brings in the eye to aid the mind. To remember forms, make a drawing, if possible, for the same purpose. Eighth: In travel, have a map and locate on it towns, streams, etc. In reading, recall the location of places mentioned or find them on the map if not familiar with them, so that you will have an idea of the places where the events narrated occurred. Attention, repetition, and classification seem to be the most important aids to memory.

Mr. Boring likens memorizing to photographing, and says four things are needed in both: a sensitive plate, exposure, a developer, and a fixative. In memorizing, the mind is the sensitive plate; placing before the mind the object to be remembered is the exposure; attention is the mental developer, and repetition the mental fixative.

We have a musical memory which enables us to recall to mind the music that we have heard, or to fix in the memory new pieces of music, so that we can play or sing them without the notes; and the memory of old familiar songs and hymns becomes a very great source of pleasure as we advance in years.

The library of Memory is one that we must read over and over again whether we will or not, for our memories are really ourselves. If we could

forget all our sorrows and pains and recall only our joys and pleasures, we should, in reality, have lost a great part of ourselves, and as we cannot forget if we would, we will prove our wisdom by reading good books, choosing wise friends, and doing lovely deeds, for these will add not only to the happiness of our earthly life but to the joys of eternity.

As Charles Kingsley says:—

"Be good, dear child, and let who will be clever;
Do noble deeds, not dream them all day long;
So shalt thou make life, death, and that vast forever,
One grand, sweet song."

CHAPTER XXIX.

THE PICTURE GALLERY.

MEMORY is not only a library but also a picture gallery. Here are stored away many of the scenes photographed by the eye, or the pictures which at various times Imagination has painted. We begin this gallery in our early childhood, and among the first pictures placed there are pictures of father, mother, brothers, and sisters, the old home and school-house —

> "The orchard, the meadow, the deep tangled wildwood,
> And every loved spot that our infancy knew."

Phoebe Cary says:—

> "Among the beautiful pictures,
> That hang on Memory's wall,
> Is one of a dim old forest,
> That seemeth the best of all."

And we find that the poets make their strongest appeals to our hearts when they are talking of the fond memories of their childhood.

> "I remember, I remember,
> The house where I was born;
> The little window where the sun
> Came creeping in at morn,"

says one. Others sing of "The Old House at Home," "The Old Oaken Bucket," or "The Old Swimming Hole"; and every time they sound a note it puts in motion those tones of influence which set our own heart-strings throbbing. Blessed are we, if, in the retrospect of child life, we have only beautiful scenes to deck the walls of memory. Sometimes, however, there are scenes we would be glad to forget—remembrances of deeds we once did that now make our hearts ache. I have heard of a little girl who was asked by her sick mother to bring her a drink of water, and the child was unwilling, and went away and stayed all day at her play, and came home at night to find her dear mother had died. What a sorrowful picture to look at during the long, long years to come.

It is sometimes hard to separate the Memory pictures of childhood from those of Imagination. We used perhaps to hear someone often spoken of, and pictured a personality belonging to the name that became as real as if we had actually known the individual. We have heard of some wonderful deed of our own childhood so often related that we imagine we really remember its occurrence. Then, too, we have illustrated the books we have read with pictures of our own imagination so that they are almost like memory, so real do they seem. You have imagined Robin-

son Crusoe in his island dress so often that you would recognize him if you were to meet him on the street. And you certainly have been inside the "Old Curiosity Shop," and have seen little Nell. You remember perfectly well how ridiculous "Alice in Wonderland" looked when she nibbled the cake and her neck grew so long and she exclaimed, "Curiouser and curiouser!"

Memory and Imagination are two marvelous artists, ever busy painting for you. Come, draw your chair to the fire, close your eyes, and look at the scenes they delineate. They come like living creatures trooping across your mental canvas, one picture fading away as another comes to take its place. Some bring us smiles, others bring tears, some you would like to look at forever, others you would fain forget; but there they are, coming and going, indelibly impressed on the brain, each day adding to the faces, scenes, and landscapes, a collection continually increasing from birth to death.

CHAPTER XXX.

THE CHAMBER OF PEACE.

WE have learned where, in the brain, lie certain centers of motion, and we are convinced that there are centers of thought and feeling, though we have not as yet located them. We ourselves can visit the hidden chambers in this marvelous upper story of our wonderful house, but we cannot teli others where they are to be found, nor may we take even our dearest friends with us into their secret recesses.

Some of these apartments are not very delightful. They may be dark and full of pictures of evil, and it makes us miserable to visit them, and yet perhaps we love to linger in them. They are little alcoves connected with the picture gallery, and we employ an artist called Imagination to paint for us the pictures that adorn their walls.

There is a Chamber of Hatred, and for this Imagination paints dark, forbidding scenes, in which we see ourselves doing unkind things to wound or injure those we do not love, and we take an evil pleasure in imagining the pain or grief we can cause.

There is the Chamber of Envy, and here we sit while Imagination paints the fine carriages and horses, elegant houses, splendid dwellings, and dresses, the beautiful faces and desirable belongings that someone owns, and we say, "Oh, I wish I owned them!" and then we are very unhappy because they are not ours. To linger long in this room is very dangerous, for sometimes a dark spirit called Temptation creeps in and whispers to us that we might possess ourselves of some of these belongings of others. Theft, murder, and all sorts of crime are planned in this dark chamber. Oh, let us hurry away from the Chamber of Envy and shut the door so tight that the evil Temptation will be imprisoned therein never to get out, because we will not open the door.

The Chamber of Selfishness, I think, must be the central room around which all the other dark alcoves are gathered. In this room Imagination paints many strange scenes. He delineates us just as we think we are, and then we fancy that people do not pay us enough attention. He shows us the beautiful possessions of others and contrasts them with our own meager belongings, and we are jealous and unhappy. If we feel moved to do a generous deed and chance to slip into the Chamber of Selfishness, we at once see a picture of how much trouble it will be and of how

little gratitude we will receive in return, so we close the door and stay shut in with ourselves, and then perhaps wonder why we are so unhappy.

There are many dark rooms that we visit, but let us look away from these to the bright and lovely chambers wherein Man finds peace and comfort. These charming rooms are alcoves surrounding one central apartment, the Chamber of Love, and here Imagination paints with bright and glowing colors the most entrancing scenes. I picture this Chamber of Love as a circular room with a dome-like roof, azure-tinted, glowing with a soft ethereal light reflected from the ceiling and from the exquisite pictures upon the walls: pictures in which kindly, unselfish deeds are depicted in all their beauty. How often the faces of father, mother, sister, or friend appear in these scenes: the faces of those whom we love and for whom it is so easy to do some deed of kindness! But brightest of all are the portrayals of lovely things we have said and done to someone who has been unkind to us; and as we look, words of golden light gleam out upon the walls and we read, "Love them that hate you;" "Perfect love casteth out fear;" "God is love;" and our hearts grow tender, and gentle tears fall from our eyes, and we feel inspired with impulses toward all that is holy and best.

And then the doorway opens into the most secret and lovely room of all, the Chamber of Peace, wherein we meet and talk with the spirit of Divine Love. I think this was the room that Jesus was thinking of when he said, "Enter into thy closet, and when thou hast shut the door pray to thy Father which is in secret, and thy Father which seeth in secret shall reward thee openly." He did not mean a closet of the house we have built for ourselves, but he meant a secret room within ourselves, a place where the world can be shut out and we can find rest and peace. I fear we do not seek this room as often as we might, for here are the great stores of comfort for every sorrow, of rest in all weariness, of strength in all trial. It does not matter that we do not know just where, in the material brain, this Chamber of Peace is located, we can learn the way thither:

"Too eager I must not be to understand
How should the work the Master goes about
Fit the vague sketch my compasses have planned.
I am His house — for Him to go in and out.
He builds me now,— and if I cannot see
At any time what He is doing with me,
'T is that He makes the house for me too grand.

"The house is not for me, it is for Him;
His royal thoughts require many a stair,
Many a tower, many an outlook fair,
Of which I have no thought, and need no care.
Where I am most perplexed, it may be there
Thou makest a secret chamber, holy, dim,
Where Thou wilt come to help my deepest prayer."

— *George Macdonald*

"Thou who hast made my home of life so pleasant,
Leave not its tenant when its walls decay;
O Love divine, O Helper ever present,
Be Thou my strength and stay."

— *John Greenleaf Whittier.*

PART II.

The Guests Man Entertains in His Bodily Dwelling

CHAPTER I.

HELPFUL GUESTS.

"A MAN is known by the company he keeps," says the old adage, and I think we can judge pretty well of a person whom we have never seen if we know his company. If he associates with refined, intelligent, Christian people, we can guess that he himself is of the same character. If his friends are dissolute, profane loafers, we know at once that he is not an industrious, moral man. It is also true that a man's house will tell something about him and his companions. When a house shows taste in its construction, neatness and care in its keeping, we judge by these things of the man who owns it, and we quickly form an opinion about him.

The appearance of the body indicates very clearly what kind of guests are entertained therein, for all visitors may be classed under two heads, constructive and destructive. They come either to build up or tear down, and the effects of their work are seen on the outside of the house The builders keep him plump and rosy, with bright

eyes, active limbs, and a general appearance of well being. The destroyers make him very pale and thin, or they fill him up with a poor quality of material and make him look too fat. They take the brightness out of his eyes and the strength from his limbs. It is therefore very important that man should entertain only those who come to help him keep his house in repair, and these are called foods.

Man chooses his own guests, but he often invites to his house those that injure him. He does not know their true character. He thinks them friendly because they have a fine appearance; or Taste says he likes them, and so they are invited in over and over again, and do great mischief before he finds them out. If we ought to choose many companions with great care, it should be those who are to come in and dwell with us and become a part of our household.

The first and most important food-guest is Oxygen. He comes in with Aura on her first visit and begins his beneficent work; in truth, Aura comes principally to bring Oxygen, and his business is to cleanse the impure blood from its dark color to the bright scarlet of pure blood. The blood could not do its work in any part of the body if it were not plentifully supplied with oxygen. We are told that a man who is at rest con-

sumes twenty-two cubic feet of oxygen in a day; and, of course, if he is at work, he will consume much more. When we remember that we consume about one twenty-fifth of the oxygen that is brought into the lungs by the air, and that the air is only one-fifth oxygen we get some idea of how necessary it is that the air of rooms and houses should be constantly changing so that oxygen may be renewed, for you will remember that carbonic acid gas is thrown out at each breath and poisons the air. It is the business of air to bring in oxygen, and to take out carbonic acid gas. We think it very important that we should eat three times a day but we sometimes forget that this most important food, oxygen, should freely enter our house eighteen or twenty times a minute.

The second guest brought to our house is a pale, sweet creature called Milk. Although she looks so delicate, and we sometimes sneer at her as being "only food for babies," she is in reality a perfect food, bringing with her everything needed to keep our house in repair. Milk is albumen, sugar, fat, and a small amount of mineral matter, dissolved in water, which you see makes it ready at once to be easily assimilated. It is especially suited to infants, as they at first have no saliva to digest starch, and cannot appropriate such foods as arrow-root, rice, sago, and similar things, which are often

We cannot eat iron, lime, or these inorganic substances in their crude state, but plants can. They take from the soil all these substances and make them over into themselves, and then we get them from the plants. If we do not eat foods which contain these inorganic substances in sufficient quantities, we break down. The bones contain a great deal of lime, and if they cannot find it in the food, they become curved and twisted and the body grows out of shape.

Phosphorous is an inorganic substance needed to build up nerves and brain; silica is used in the hair and nails; and when we look about to see where we can find these substances made over for our own use, we learn that phosphorous is found especially in the germ of grains, and silica in their outer covering, and this is another reason why we should not bolt our flour but should leave in it the elements as they were placed there by God himself. James Russell Lowell says, "Behind the nutty loaf is the mill-wheel; behind the mill-wheel is the wheat-field; on the wheat-field rests the sunlight; above the sun is God."

If we were to invite into our bodily dwelling only those guests which build us up, and these in the right proportion, it is doubtful if we should ever know much about sickness. This being the case, would it not be well to study the matter

carefully, not considering merely what tastes good, but what is needed to keep us in repair, and to avoid those things which are destructive? Great and good men have at all times given thought to the subject of food and have left on record many wise sayings in regard to it. If we knew the value of various kinds of food, we might even cure diseases by selecting a proper article of diet instead of using drugs. Dr. Hunter, a very eminent physician, and a sufferer from gout, found apples a remedy, and insisted that all his patients should use apples instead of wine and roast beef. Professor Farrady says, "If families could be induced to substitute the apple (round, ripe and luscious) for the pie, cake, candy, and other sweetmeats with which children are so often stuffed, there would be a diminution of doctor's bills." Many of the ancient writers have left on record their belief in a simple diet, often entirely discarding animal food. Socrates says, "To fare well implies the partaking of such food as does not disagree with body and mind; hence only those fare well who live temperately." In ancient Greece the food was plain and simple, and the athletes were trained entirely on vegetable food. We use the word vegetarian for one who eats only vegetables, but I have seen it stated that the word is derived from the Latin *vegetus*, which means strong,

robust and hardy, and it is perhaps because vegetable food tends to health that we have come to call those who eat it, vegetarians.

It is claimed by those who object to animal food that Milton was a vegetarian, and that Newton wrote his "Principia" while living entirely on vegetable food. It is known that Shelley ate no meat. It is said by Xenophon, that Cyrus, king of Persia, was brought up on a diet of water, bread and cresses till his fifteenth year, when honey and raisins were added. Xenophon also describes the outfit of a Spartan soldier who lived principally on bread and dried fruit. His ordinary outfit weighed seventy-five pounds, which was often increased to a full hundred, and this load was often carried at the rate of four miles an hour for twelve hours a day, many days in succession; so, even if we do not admit that it is best to give up meat eating entirely, we must confess that health and strength can be maintained without meat, and certainly there is more that is pleasing to think of in the fields of ripened grain, in the fruits hanging from the boughs, than there is in the slaughter of animals.

Ancient Gauls, who were very brave and strong, lived on milk, berries and herbs. Their bread was made of nuts, and they had a strange fashion of wearing a metal ring around the body the size of

which was regulated by law. If any man grew larger around than his ring, he was thought to be a lazy glutton and consequently was disgraced. Certainly, the motto of that people must have been one which would be wise for us all to adopt: "Let appetite wear reason's golden chain, and find in due restraint its luxury."

CHAPTER II.

SPICY VISITORS.

WHEN I began to speak of foods as visitors to our bodily dwelling, I did not realize how much they are like real folks. We all know people who are plain and unpretending, but so reliable and trustworthy that we value them exceedingly. We are glad to see them every day, and if in need of friends, we call for them instead of our more showy companions. We sometimes say of such a one that he is "as good as gold." The Italians have a better saying: "He is as good as bread," and that is a great compliment. What is better than good, honest plain bread when we are in need of food? Such constant friends as bread, meat and potatoes we are glad to welcome every day as helpful guests.

We enjoy occasional visits from people who are very sweet, but if they come too often or stay too long, we get very tired of them. This is true of sweet foods, they cloy the appetite; we can take them along with plainer foods, but they are a poor dependence for the work of building us up.

Then there are people who are so lively, so clever, their wit is so pungent, their jests so spicy, that their coming stirs us up into unwonted activity, and when they are gone we say we "just feel all tired out." Such guests sometimes come to our marvelous house. We call them condiments. They are known more particularly as pepper, mustard, spices, sauces, etc. Many people have accustomed themselves to foods so highly seasoned that they cannot enjoy the flavor of the food, just as people become so fond of society that entertains that they can't enjoy a good serious, sensible conversation, and that is unfortunate. But these spicy food guests are, in truth, more to be avoided than spicy people. They are not builders, they are sources of irritation. Mustard on the outside of the body produces a blister, and can you imagine anyone blistering himself because he enjoys it? Why then should he like to irritate in the same way the more sensitive mucous membrane of the mouth and stomach? The same may be said of pepper and all pungent, biting substances; they irritate and cause inflammation of the mucous membrane. Every physiology mentions Alexis St., Martin, a man in Canada, who in 1848 had a wound in his stomach which healed up leaving a flap of flesh that could be pushed aside, giving a view of the inside of the stomach and what it was doing. For-

tunately for science, the doctor who had him in charge was wise enough to improve his opportunity and because of this we now know, as never before, some of the secrets of our bodily kitchen.

Dr. Beaumont reports that when St. Martin took pepper and other condiments with his food, the mucous membrane of the stomach grew red, just as the eye would if the same substances were put into it. Why do we like them then, if they are so irritating? I doubt if we do like them naturally. Did you ever see a baby that wanted pepper? I never did. I have seen children two or three years old who would pepper their food, but they did it at first because they saw the older people do it, and after a time they grew to be fond of these things. It is one peculiarity of our bodies that they can soon accustom themselves to very hurtful things and seem to miss them when they are taken away. I once heard of a woman who could not sleep after her snoring husband died unless someone ground the coffee mill in her room, but I suppose none of us would think that an argument in favor of snoring as a lullaby. If the story is true, which is doubtful, it only illustrates the fact that we can become accustomed to very disagreeable things. In the case of condiments, such as pepper and mustard, the nerves of sensation complain at first of their biting, but by and by they

find complaining does no good, so they keep quiet and finally end by liking to be bitten. It is another illustration of Pope's lines concerning vice. He says:

> "Vice is a monster of so frightful mien,
> That to be hated needs but to be seen.
> But seen too oft, familiar with her face,
> We first endure, then pity, then embrace."

So it is with these stimulating substances, for all condiments are stimulants, and stimulants are things that get more work out of you, without putting strength into you, and that is not desirable. The spices we add to foods do not build up any tissues of the body, but they act like spurs or whips, to excite the nerves and mucous membrane to greater activity. But do they not help digestion? A series of experiments has been conducted by Dr. J. H. Kellogg, at the Battle Creek, Mich., Sanitarium. He gave a breakfast to a healthy young man, and an hour after, by means of a stomach pump, took it away, and had a chemical analysis made of it to learn the effects of different substances, and he learned that all condiments actually retard digestion.

One fact in regard to condiments, that to me is an argument against them, is that their use must be increased to maintain our enjoyment of them, which is not true of the foods, and this proves that

their use deadens the nerves of sensation. This, of course, lessens our power to appreciate delicate flavors. Where the mucous membrane of the mouth and stomach is seared and burned by high and unnecessary seasoning, the bland and ethereal flavor of food, as God gave it to us, is lost, and so we actually miss the highest enjoyment of eating in our unwise effort to create new pleasures of appetite.

CHAPTER III.

QUESTIONABLE GUESTS.

IT is not a very welcome task to warn people against those whom they believe to be their true friends, but it is sometimes our duty, and therefore should be bravely done. I hope you young people have as yet never made the intimate acquaintance of two foreigners who are frequent guests in the bodily house, although, no doubt, you are very familiar with their appearance. One of them has a dark complexion, and is rather bitter, unless associated with milk and sugar. His name is *Coffea Arabica*, and you know him as coffee. He was introduced into England and France about two hundred years ago; so if you think people cannot get along without coffee, you have only to study up what was done in France and England in deeds of bravery or in literature before coffee was ever known. Coffee is a native of Abyssinia. It found its way into Arabia in the sixth century and probably as a substitute for wine when that drink was prohibited by the Koran. By the sixteenth century, it had reached Cairo in

Egypt; but here the great men rose up against it, and declared it contrary to the law of their prophet and injurious to both soul and body. Ministers preached against it, and it doubtless would have been abandoned had not the Sultan come to its aid and declared it to be not objectionable. In Constantinople and also in Italy, it met with opposition both from the clergymen and the physicians. Medical science to-day calls coffee a stimulant, and the testimony of physicians would certainly induce us to be wary of making a friend of coffee.

Professor Hitchcock says the bewitching influence both of tea and coffee lies in their narcotic property. Dr. Bartholow says: "If used to excess as a beverage, coffee deranges the organs of digestion, producing acidity, flatulence, pyrosis, eructations, headache, vertigo, ringing in the ears, and wakefulness." Dr. Emmett, another authority, says: "I find coffee, even when weak, to exert a very deleterious influence, in consequence of its direct influence on nutrition. Whenever a patient has become addicted to the use of stimulants, anodynes, or coffee, an effort must be made at once, without a compromise, to break up the dependence upon either of these insidious poisons to the nervous system."

It is sometimes said as an argument in favor of

coffee that it is an indirect food because it checks waste. In the healthy body the checking of normal waste is not desirable.

A very serious objection to the use of coffee by young people is that it satisfies the desire for food without contributing any constructive material for the nourishment of the body. Children and young people are continually growing by the addition of new material to their bodily organs; they therefore need to eat plenty of nourishing food, and if coffee satisfies the appetite so that they are inclined to eat less than the body actually demands, it is easy to understand that it is doing the body an injury. Many people imagine that the powers of intellect are increased by the use of coffee. Dr. Kitchen says: "The great damage from coffee is brain-wear." The testimony of a man with originally good intellect and moral powers as to its effect both upon mind and morals will be of value. "When I awake," he says, "I have the intelligence and activity of an oyster, but immediately after coffee, stores of memory leap, so to speak, to the tongue, and talkativeness, haste, and the letting slip something we should not have mentioned are often the consequence. Moderation and prudence are always wanting. The cold, reflective seriousness of our forefathers, the solid firmness of their wills, resolutions and

judgment, the duration of their not speedy but powerful and judicious bodily movements,— all this noble, original impress of our nature disappears before this medicinal beverage, and gives way to over-hasty attempts, rash resolutions, immature decisions, levity and fickleness, talkativeness, inconstancy, and rapid mobility of the muscles."

The statement is made that caries of the bones in young children is connected with the use of coffee. It produces also a species of fever sometimes called children's hectic. Their faces become pale, and their flesh soft, and when they have learned to walk, their step is very unsteady, appetite is feeble, they do not grow naturally, they are apt to be timid, discontented, to sleep badly, are troubled with sore eyes, and their teeth come with difficulty. Increase of heart disease is also, by some physicians, attributed to the increased use of coffee.

The other foreigner is named *Thea Chinensis*, but he is generally known as Tea, and from his complexion designated as Green Tea or Black Tea. In the quaint diary of Mr. Pepys we find the entry Sept. 25, 1660: "I sent for a cup of tee — a China drink, of which I had never drunk before." So we see that until nearly that date, tea had been unknown in England: and when

people tell us that tea is an assistant in mental work, we can point to them the fact that a good deal of fine intellectual work was done in the world before tea was known. In those days the facts of physiology and hygiene were not known as they now are and people judged of food and drinks, as many yet do, by their feelings, and, as tea and coffee made them, for the time being, "feel good," they very naturally supposed them to be good, and attributed many virtues to them. As we are very desirous of keeping our bodily dwellings in repair, we will certainly be willing to hear frank statements of scientists in regard to tea and coffee.

The Rev. John Wesley leaves on record that he discovered that tea gave him symptoms of paralysis in a shakiness of his hands which ceased when he quit tea-drinking. Dr. Beddoes, of England, demonstrated that a strong decoction of tea is destructive of life, both human and animal.

Dr. Beaumont, who had charge of Alexis St. Martin, of whom we have before spoken, observed the effect of tea and coffee upon the lining membrane of the stomach, and says that their use has a tendency to delibitate the digestive organs. Hot drinks injure the teeth, the gums, the lining of the stomach, and so, indirectly, the whole system. People who drink much while eating do not chew

their food enough and so do not mix it thoroughly with saliva, and Dr. Beaumont discovered that swallowing food not perfectly masticated produced eruptions and ulceration of the mucous membrane of the stomach. It is said of tea as of coffee, that it lessens the waste of tissue, and therefore is an indirect food. Of this fact, Dr. Page says that to interfere with, or to hinder any of the normal processes of the organism, especially those most vital to the constant breaking down and excretion of tissue, is not only to invite disease, but the impairment of those functions constitutes disease.

Prof. Albert B. Prescott, of the University of Michigan, who, as a chemist, has investigated the properties of tea and coffee, says that the caffein of the one and the thein of the other are built on the chemical type of the alkaloid, a class of bodies which nature forms in plants but not in food-plants. This class of bodies includes narcotics, stimulants, hypnotics, deliriant poisons, which either excite or depress the nervous system.

Dr. Richardson, a physician and great scientist, asserts that the misery of the women of the poorer classes of England is more than doubled by the use of tea. Dr. Ferguson, an eminent physician, studying the effects of tea and coffee upon the health and growth of children, says that children

allowed those beverages average a gain of four pounds a year between the ages of thirteen and sixteen, while those who were given milk instead, average fifteen pounds a year gain in the same period.

Is not all this testimony sufficient to make us, who have not yet made the intimate acquaintance of these two foreigners, say we will not put ourselves into the power of companions who bring us nothing of good but are so powerful to do harm?

CHAPTER IV.

TREACHEROUS COMPANIONS.

A FRIEND who fails, out and out, to keep his promise, is one who cannot injure us greatly, for we soon learn to distrust and avoid him; but one who makes us believe he is keeping his promise to help us while, in truth, he is all the time secretly injuring us, is the one who can do us the greatest harm because of our confidence in him.

If you employed a man as a special guardian of your house, and he promised to take care of the premises while you slept, and then he should take advantage of your trust to undermine the foundations, to break the windows, to tear down the electric wires so that you could receive no word of the mischief he was doing, he might, in truth, be called a false friend, and you ought to feel grateful to anyone who would inform you of the true state of affairs, and warn you against trusting one so unworthy. It is such a note I would now sound in your ears, warning you against a class of visitors who will make wonderful promises of assistance, but if allowed to become your guests,

will work great mischief. They all come promising to add to Man's comfort, to make him forget his cares, to help him to sleep, and to close the warning mouth of Pain, whom Man so often fails to recognize as a friend.

Perhaps the most widely known among these false friends is Opium, a dark, unpleasant-looking creature, whose influence over Pain is very remarkable, and it is scarcely to be wondered at that Man receives him with a hearty welcome when he once learns how quiet Pain becomes under the influence of Opium, but when we learn the method by which Pain is stilled, we find it not desirable. We know that Pain's complaint means that something is wrong about the house, and we should seek to know what is wrong and right it; then Pain would subside of his own accord. But Opium throttles Pain, as it were, and prevents his talking; or, more truly, he paralyzes the nerves of sensation so that the messages of Pain are not received at the General Office and the mischief of which he is giving information goes on uncorrected.

Because he hears no more grumbling, Man imagines that everything is as it should be. After a time, the paralyzing influence of Opium passes away, and then Pain renews his complaint more loudly, and Man, in his agony, again calls on his false friend to come to his aid. In this way he

becomes a slave to Opium, and the bodily house is thrown into such a state of revolution that it is only when the tyrant Opium reigns through his paralyzing power that Man has any peace.

The habit of opium-using in various forms, as laudanum, morphine, or opium-smoking, may be called intoxication, from a Greek word, *toxicon*, meaning poison. All these false friends are poisons, and they all work in the same fashion, by creating such a demand for their presence that they become tyrants, and Man their slave.

The poet Coleridge, who for many years was addicted to the use of opium, says: "My case is a species of madness, only that it is a derangement and utter impotence of volition and not of the intellectual faculties. You bid me rouse myself. Go and bid a paralytic in both arms to rub them briskly together and that will cure him. 'Alas,' he would reply, 'that I cannot move my arms is my complaint and misery.'" I am glad to tell you that Coleridge, after a fearful struggle, was freed from the dominion of opium. De Quincey, who was also an opium slave, but who freed himself from the tyrant, says: "I triumphed, but think not that my sufferings were ended. Think of me as one, who, even when four months have passed, is still agitated, writhing, throbbing, palpitating and shattered."

The use of opium affects not only the physical system but the moral nature. Dr. Kerr, who has made a very thorough study of the effects of narcotic poisons, says that under their use love is transformed to hate, and the one who uses them often loathes the sight of those whom he used to cherish with the tenderest affection. He continues: "Opium transforms the manly, high-toned, pleasant companion into an effeminate, driveling, querulous bore. It transcends alcohol in the generation of a more irreclaimable and incurable diseased condition. Cured alcohol-inebriates are not uncommon, cured opium-inebriates are comparatively few in number. The perception is so clouded that they are not amenable to intellectual and other elevating influences."

Another false friend, not much over twenty years old, is Chloral Hydrate, whose chief attraction is his power to produce sleep; but he, like all sleep-producing drugs, accomplishes this only by destroying the ability to sleep. He interferes with digestion, oppresses the heart, disturbs circulation, and affects the work of the nervous system.

Chlorodyne and Chloroform are relatives of Chloral Hydrate, and their effect is similar in the deadening of sensation and the working of

mischief while Man is unconscious. Cocaine may be included in this list. This is a powerful drug, and like those before mentioned, may have a valuable work to do in the hands of the skilful physician, but, if taken at the will of the individual, soon becomes a tyrannical master who caresses only to destroy. Its first effect is a feeling of increased mental and bodily power, but sleeplessness and depression and a train of direful evils follow, and the ultimate tendency is to produce delirium and raving madness.

Absinthe and Haschish are friends of this character, better known in foreign lands than our own. We must not forget to mention ginger as of this class. It is usually associated with alcohol before its use becomes a slavish habit, and so united it becomes destructive to the stomach and causes a persistent gnawing feeling through depraved mucous membrane and nerve disturbances. These ginger extracts are usually purchased by women who, perhaps, have little idea that they are becoming drunkards by their use. When we remember that only those substances which contain the material to rebuild the body can truly be called foods, and that these are the only substances that should be taken regularly into the system, we have a guide in our choice of visitors to our bodily house, and if we are truly wise, we

will refuse admission to those whom we do not know to be builders.

We could very well put up with the tearing down of our dwellings by carpenters who were preparing to rebuild it, but we would have little patience with a troop of boisterous invaders who would tie us fast while they destroyed our most precious possessions. We should be equally impatient with such false friends as we have described in this chapter, and utterly refuse their admission to our bodily dwelling.

CHAPTER V.

A DECEITFUL FRIEND.

AMERICA has the responsibility of introducing to the world one who has become an intimate companion of both the high and the low. Tobacco has held his place in spite of the fact that his first introduction into the bodily house is usually accompanied by serious upturnings. He is so universally disagreeable to every member of the household that all unite in a desperate effort to get rid of him: an effort so terrible, in truth, that during the struggle the whole contents of the kitchen may be emptied out of the front door, all the guardians and servants be greatly disturbed in their duties, and work in most parts of the house be temporarily suspended. This most unpleasant visitor has a dark complexion, and carries with him an evil odor that ought to forbid his admission into any respectable household. He comes of a low family. The deadly Nightshade, the Horse Nettle, Jamestown Weed, and Henbane are near relatives of his; but, like some other bad folks, he has some relatives who are beautiful,

such as the Night-blooming Jasmine; or useful, as the Potato and Tomato, who are his second cousins.

Are you now willing to learn what science says of Tobacco? We feel obliged to accept the statements of Science, for they are records of facts, and are not in the interest of any theories of reform. Scientists study the body and set down just what they find, letting it prove or disprove what it may, and they have been interested in investigating the effects of Tobacco in the various disguises in which he enters the house.

Sometimes he comes dressed in white and looks very dainty, and in this form is called a cigarette, and to many he appears as if quite harmless. Little boys are often most anxious to make his acquaintance, and sometimes become so fond of him that they say they cannot give up their friendship with him. Yet even in this charming guise he is black at heart and does most destructive work in the house. It is said that he often brings with him the false friend Opium, and that frequently the white paper in which he is wrapped is bleached with arsenic. Tobacco always carries with him a deadly poison known as nicotine which is found as an oil, and it is said that this oil is seven per cent of the whole weight of the tobacco leaf. And what does nicotine do? "Nicotine

primarily lowers the circulation, quickens the respiration, and excites the muscular system, but its ultimate effect is general exhaustion. Administered in the minutest doses, the results are alarming, and in larger quantities will occasion a man's death in from two to five minutes." This, of course, means the pure nicotine separated from the other substances in the tobacco. Well, I, for one, do not want anything to do with a visitor who steals into my house to do such harm as that, do you?

Franklin found that if tobacco smoke were passed through a stream of water, oil would appear on the surface, and that oil applied to the tongue of a cat would kill it, for that oil was nicotine. You would n't drink water through which tobacco smoke was passed, you say. Of course not; but you often have to breathe air that is filled with it, for the nicotine goes off with the smoke, and not only the smoker, but everybody around suffers.

Tobacco sometimes comes as a visitor to the bodily dwelling in a brown dress, as a cigar; or he may be carried in a conveyance called a pipe, and some men spend more time and take more pride in coloring a meerschaum pipe by tobacco smoke, than they do in gaining a profession; so we see what an ignoble ambition it stimulates.

Occasionally we find a person who takes Tobacco into closer companionship, and invites him into the reception room, rolls him over in familiar association with his tongue, presses him between his teeth, and then casts him out.

This chewing is the most disgusting form of friendship with Tobacco, and is particularly hurtful in that it puts a great deal of unnecessary labor on the salivary glands, and then throws the result of their labor away.

Snuff taking used to be quite fashionable. In this habit, Tobacco in the form of a fine powder is taken into the nose. Very few people use snuff nowadays, yet in the South we find it sometimes used by women who dip a stick into the snuff and then chew it. Some people claim that Tobacco is good for the teeth, but the testimony of many dentists is to the effect that while it may deaden pain, it hastens decay.

Although Tobacco is not allowed to penetrate farther than the reception room, his poisonous influences are felt all through the house. His first influence will be on the lips, tongue and throat, and serious irritations or even cancers may follow. The cancer of Senator Hill is said to have been the result of smoking, and it is the belief of many physicians that the frightful throat difficulties of General Grant and the Emperor Frederick

were in a great degree the result of smoking. Doctors who have had the opportunity of observation easily recognize the smoker's sore throat.

All users of tobacco will recall their first experience and admit that it had a serious effect on the stomach. Tobacco smoke necessarily irritates the bronchial tubes and lungs which were made to deal with pure air, and not with that poisoned with nicotine, and serious lung affections are caused or greatly increased by smoking. One of the famous Delmonico brothers of New York used to smoke a hundred cigars a day, and died from a morbid enlargement of lung cells that caused fits of coughing that nearly strangled him.

The effect of nicotine on the blood is to make it watery and change the red corpuscles so that they rapidly go to pieces, and the ratio of degenerated corpuscles may go as high as one to ten healthy ones. This condition of the blood is shown by the microscope. A man who had been selecting a microscope, left on the slide a drop of his own blood, which he had used as a test. A professor of microscopy saw the slide and said to the dealer: "Tell that gentleman, if you can without impertinence, that unless he stops smoking at once he has not many months to live." A few weeks later he died, and the doctors called his disease a "general breaking-up."

A Cincinnati paper tells us that at one time the sister-in-law of General Sherman was ill and it was thought that transfusion of blood might save her life. Blood was therefore conveyed to her arm from that of her son, an apparently vigorous young man, but a great smoker. In a few moments she exclaimed: "Who is smoking? I taste tobacco." No one was smoking, but the small amount of blood drawn from the veins of the young man was so saturated with tobacco that it had been recognized by her sense of taste. She died shortly after with heart failure. This gives an idea of the effects of tobacco in poisoning the blood, and explains how it interferes with the growth of the young. Children grow only by having good blood carried to all parts of the body. If one-tenth of the blood is made of broken-down cells, it cannot build up strong nerves, muscles and bone, and so the smoking boy may not grow to full size. This lack of growth does not result alone from a poor quality of blood, but from the debility and irregularity of the heart's action, caused by the nicotine. Brodie says: "It powerfully affects the action of the heart and arteries, producing invariably a weak, tremulous pulse, with all the apparent symptoms of approaching death."

Another physician says: "If we wish at any

previous to their using tobacco, could send a bullet through a target at eight hundred yards, but after they became smokers were so nervous that they could scarcely send one into a hay-stack at a hundred yards." The hand of the smoker often trembles so that he cannot draw a clean, straight line, and it is said that tobacco-using applicants for the situation of book-keeper have been rejected because of their tremulous handwriting. Our baseball players are learning that the man who uses tobacco may have a defective eyesight which lessens his ability as a batter. The use of tobacco causes a dilation of the pupils of the eye and confusion of vision. They frequently find, too, that when they shut their eyes the images remain visible a long time because of the impaired activity of the nerves of the retina. A peculiar kind of blindness is attributable to the use of tobacco, which will not be relieved by any remedies as long as the habit of smoking is continued, and frequently is utterly irremediable.

One doctor says that tobacco produces a contraction of the blood vessels which causes anæmia of the nerve structure, and this, of course, weakens the nerves and causes them to degenerate. The ear is also affected by the use of tobacco. Sometimes there is an inability to hear clearly, and sometimes there are roaring sounds in the ears.

In other cases there will be chronic catarrh and inflammation of the middle ear, extending down the Eustachian tube into the throat. Actors and singers are learning by experience that the use of tobacco injures the voice, rendering it coarse, tremulous and husky.

The effect upon the brain and nerves is very marked. A member of the Paris Academy of Medicine says that statistics show that in exact proportion to the increased consumption of tobacco is the increase of diseases in the nervous centers: insanity, general paralysis, paraplegia, and certain cancerous affections.

The superintendent of the Pennsylvania Insane Hospital says: "The earlier boys begin to use tobacco, the more strongly marked are its effects upon the nerves and brain." Professor Kirke says: "You see a man weary, and yet restless. By means of the narcotic this nervous irritation is subdued. The supply of vital force from the organic centers to the motor nerves is so much lessened that the irritating movement in them ceases. This gives a sense of relief to the person affected. He is not aware that the benefit is purchased at a very serious cost. He has not only lessened the supply of vital force for the time being, but has done a very considerable amount of injury to his vital system. He has, in fact, poisoned the

springs of life within him. As soon as these nerves rally from the lowering effect of the narcotic, the irritation returns, and the narcotic is called for anew. Fresh injury is inflicted for the sake of the ease desired. This goes on till the vital centers, if at all delicate, totally fail to give supply to the motor nerves, and paralysis begins. Yet the man goes on indulging in the so-called luxury of the narcotic." Physicians are even beginning to ascribe delirium tremens to the exasperating agency of tobacco upon the human nerves and organism.

The evil effects of tobacco are not confined to the physical powers but are also felt in the intellectual capacity. Presidents of colleges, superintendents of schools, educators everywhere are giving their unqualified testimony upon this point. In 1863, the Emperor Louis Napoleon, learning that paralysis and insanity had increased with the increase of tobacco revenue, ordered an examination of schools, and this brought to light the fact that the average standing, both as to scholarship and character, was lower among the users of tobacco than among the non-users, and he therefore issued an edict forbidding its use in all the national institutions.

French medical scientists made very thorough investigation in regard to the effects of tobacco in

the public schools of France, extending from 1876 to 1880, and the result was that the minister of Public Instruction issued a circular to teachers in all schools of every grade forbidding tobacco, as injurious not only to the physical, but to the intellectual development.

I heard a president of a Normal College say to his students that he could pick out the users of tobacco by simply looking at the record of recitations, and added: "If there is one boy who can use tobacco and keep up with his classes, that boy has an intellect bright enough to yield him a world-wide reputation if he were to give up the use of tobacco." The *Yale Courant* tells us that in the four grades of scholarship into which Yale students are divided, in the first grade, only twenty-five per cent use tobacco; in the second grade, forty-eight per cent; in the third, seventy per cent; and in the lowest, eighty-five per cent. A report by the medical department of the United States Naval Academy at Annapolis, Maryland, enumerates as the results of the use of tobacco in the school: "Functional derangements of the digestive, circulatory, and nervous systems, manifesting themselves in the form of a headache, confusion of intellect, loss of memory, impaired power of attention, lassitude, indisposition to muscular effort, nausea, want of appetite, dyspepsia,

palpitation, tremulousness, disturbed sleep, impaired vision, etc., any one of which materially lessens the capacity for study and application. The Board are of the opinion, therefore, that the regulations against the use of tobacco in any form cannot be too stringent." What an array of charges to bring against one who claims to be a friend!

Worse, perhaps, than all this terrible effect on the body and mind is the evil result to the moral nature. According to a New York doctor, "the universal experience of all mankind will attest, and the intelligent observation of any individual will confirm the statement that, precisely in the ratio that persons indulge in narcotic stimulants, the mental powers are unbalanced, the lower propensities acquire undue and inordinate activity at the expense not only of vital stamina, but also of the moral and intellectual nature. The whole being is not only perverted, but introverted and retroverted. Tobacco using, even more than liquor drinking, disqualifies the mind for exercising its intuitions concerning the right and wrong; it degrades the moral sense below the intellectual recognitions."

The testimony of Professor Stuart, of Andover, is that tobacco undermines the health of thousands, creates a nervous irritability, and thus

operates on the temper and moral character of men. It is the opinion of Professor Mead, of Oberlin, that the tobacco habit tends to deaden the sense of honor as well as of decency, and none are likely to practice deception more unscrupulously than those who use the weed.

Dr. Harris says: "There is no article of luxury that so secretly and yet so surely saps all the foundations of manliness and virtue as the use of tobacco. It paves the way to every vice, and tends directly to habits of the grossest immorality."

We can only account for the enslavement of moral teachers to the habit of smoking on the ground that these men began the habit of smoking years ago when the true character of tobacco was not as well known as to-day, and now, blinded by its seductiveness, they will not be convinced that it has harmed them. I think one of the saddest sights I ever saw was that of two doctors of divinity smoking together, one fast falling into imbecility with softening of the brain, and the other totally blind. The profession of piety does not save one from the penalty of violated law, and it is written, "Whoso defileth the temple of God, him shall God destroy, for the temple of God is holy, which temple ye are."

In a discourse to the graduating class at Wil-

liams College, President Hopkins, after some preliminary remarks on the use of tobacco, thus sums up: "I may express to you my conviction that habitual narcotic stimulation of the brain is not compatible with the fullest consecration of the body as a temple of God. Good men may do this in ignorance, as other things prevalent at times have been done, and not offend their consciences; but I believe that greater earnestness, more self-scrutiny, fuller light would reveal its incompatibility with full consecration, and sweep it entirely away. The present position, on this point, of the Christian Church as a whole I regard as obstructive of the highest manhood and of the spread of spiritual religion. I know that strong men have in this connection been bound as in fetters of brass, and cast down from high places, and have found premature prostration and a premature grave, and that this process is now going on. Let me say, therefore, to those of you who expect to be ministers, that I believe sermons, even those called great sermons, which are the product of alcoholic or narcotic stimulation, are a service of God by 'strange-fire'; and that for men to be scrupulous about their attire as clerical, and yet to enter upon religious services with narcotized bodies and a breath that 'smells to heaven' of anything but incense, is an incon-

gruity and an offense, a cropping out of the old Pharisaism that made clean 'the outside of the cup and platter.' Not that abstinence has a merit, or secures consecration; it is only its best condition."

It is claimed by many that the use of tobacco leads to strong drink. To be sure, many smokers do not drink, but I imagine there are few drinkers who do not smoke, and the testimony of man endeavoring to reform is that to succeed they must not only give up their drink but their tobacco.

Alcohol is often used in the process of curing the tobacco leaf. Jerry McAuley, well known for his mission in Water Street, New York, said that it is rare to find a reformed man who does not return to his cups if he continues the use of tobacco, and the effort is made in his mission to induce men not only to give up drink but the use of the weed as well. The fetters which tobacco binds around his victims are as strong as those of opium or alcohol.

I once talked with a boy of seventeen, who said he would have a good farm given him if he would quit smoking. "I want the farm," he said, "and I have tried to quit, but I cannot."

I have even heard of a boy of six so enslaved by the tobacco habit that he preferred a cigarette to candy.

I find in the book, "Tobacco Problem," this

little story: A man found himself out of flour, meat and tobacco. Having in his purse only a dollar and seventy-five cents, he went to market and came home with fifty cents' worth of meat, and the dollar and twenty-five cents' worth of tobacco, telling his wife that they must trust to the Lord for flour. If grown men are such slaves, would it not be wise for boys to keep out of such bondage? I wish they could be induced to say that they will be free; but alas! all over our land boys are beginning to put themselves into the power of this tyrant.

Not only have reformers protested against tobacco but business men are opening their eyes to the fact that its use is not only a selfish and disagreeable habit but is injurious to the best interests of business.

A prominent man who is general freight agent in a great railroad, and who employs many young men as clerks, announces that in future he will not employ any one who uses cigarettes. He says: "Among the two hundred in my service are thirty-two cigarette fiends. Eighty-five per cent of the mistakes occurring in the office are traceable to these thirty-two smokers. They fall behind in their work, and when transferred to other desks, which men who do not smoke handle easily, they get along just as badly, showing that

it is not the amount of work that is to blame, but the inability or indolence of the performer. The smokers average two 'days off' from work in a month, while the non-smokers average only one-half day 'off' in the same time. The natural conclusion is that the thirty-two young men are holding positions deserved by better men."

Mr. George Baumhoff, Superintendent of the Lindell Railway, of St. Louis, says: "Under no circumstances will I hire a man who smokes cigarettes. He is as dangerous on the front of a motor as a man who drinks. His nerves are bound to give way at a critical moment. If I find a car beginning to get irregular for any time, I begin at once to investigate the motorman to find if he smokes cigarettes. Nine times out of ten he does, and then he goes for good."

The Superintendent of the Georgia Central Railway has issued an order prohibiting cigarette smoking by the employees of the road. Many business firms in Chicago have issued similar orders. Cigarette smoking is not permitted among the employees of Montgomery, Ward & Co. Marshall Field & Co. provide bi-monthly lectures against the practice for the benefit of their employees. The reasons given by these and other business men for thus forbidding the use of cigarettes are: The odor is unpleasant;

that nicotine demoralizes the employee and affects his honesty; that it makes him nervous, stunts his growth, befogs his memory, and makes him unable to give his employer his best service.

Chief Willis Moore, of the United States Weather Bureau, has issued an order prohibiting the use of cigarettes by all employees. He says: "In the service we are compelled to maintain a very strict discipline to secure satisfactory service. Some of the men whom we regarded as most thorough and competent gradually became careless and lax. In many cases this was found directly attributable to the use of cigarettes. As a public servant I feel it my duty to correct any evil that exists, and I can state most emphatically that the order will stand, and that it applies to the entire force of the bureau throughout the service."

Business men are not sentimental but practical. It is not in the interest of reform or of philanthropy that they take such a stand, but because it affects their business, their pocket-book. The boy who desires success in business will be wise if he sees what is indicated by this movement on the part of business firms, and as he desires success in life prepares for it by the wisdom gained through the experience of others: and yet myriads of boys are beginning the evil habit.

The *Boston Journal*, in the year 1882, says:

"Seventy-five per cent of school boys over twelve or thirteen years of age, smoke cigarettes." We are glad to learn that Prof. William Stephenson, Philadelphia, has caused to be pasted in the inside of every text-book used in his school, a brief, printed statement of the physical and mental diseases produced in the young by the use of tobacco. It needs backbone to give up the habit of tobacco using, and many people are afraid to quit suddenly for fear the results will be serious, but we have the testimony of medical men to the fact that, while it may be exceedingly uncomfortable, it is perfectly safe to quit immediately.

Dr. Kirkbride says: "I have never seen the slightest injury result from the immediate and total breaking off the habit of using tobacco, and the experience of this hospital is a large one in this particular." We quote from the testimony of another physician: "The struggle of the sufferer may be terrible, he may even feel like death, but there is no danger of dying. Such a result has never yet happened. Although the pain and misery are intense, their duration is short."

To one endeavoring to break free from the fetters of tobacco using, it might be well to suggest that a great assistance will be found in avoiding all stimulating, highly-seasoned articles of food, and in the using of fruits; also in warm

bathing, or wet sheet-packing, to induce the speedy elimination of the poison through the skin.

I have written as though all the victims of the tobacco habit were men and boys, but I am told that girls are often induced to smoke cigarettes just for fun, and end by becoming constant users of tobacco. I know of one bright girl of seventeen who smokes so much that she carries with her the same odor of person as a tobacco-saturated man. What a frightful thing for a pretty girl to poison the air all about her with the odor of tobacco! And yet it is no worse for girls to smoke than for boys; and we, who have come to have a regard for the bodily house, in which we dwell in company with the divine Architect who created it, will certainly banish tobacco from our premises.

The Bible says: "When a man would build a house, he first sits down and counts the cost." It is well also to count the cost of bringing into our wonderful bodily house agencies that will tear it down. We have been counting the cost of the use of tobacco in its effect upon the nerves and blood, on heart and brain, on memory, intellect and morals; now suppose we count the cost in dollars and cents. You can figure up for yourself what would be the yearly expense of a man who smoked a hundred cigars a day, as Delmonico is said to have done. If they cost only five cents

apiece, it would amount to five dollars a day, or eighteen hundred dollars a year.

A man is considered a very moderate smoker who uses only three cigars a day: computing these at five cents each would make over fifty dollars a year. But suppose he only spends five cents a day, will you figure up what he could save if he put it out at compound interest? Or suppose he put the fifty dollars into books; at the end of a year he would not have paralyzed his nerves and poisoned his blood, and have only an empty pocket-book; he would have gathered about him a company of choice friends to be a pleasure to him through life.

Let me quote again from "The Tobacco Problem": "Some years since, the annual production of tobacco throughout the world was estimated at four billion pounds. This mass, if transformed into roll-tobacco two inches in diameter, would coil around the world sixty times; or if made up into tablets, as sailors use it, would form a pile as large as an Egyptian pyramid. Allowing the cost of the unmanufactured material to be ten cents a pound, the yearly expense of this poisonous growth amounts to four hundred million dollars. Put into marketable shape the annual cost reaches one thousand million dollars. This sum, according to careful computation, would construct two rail-

roads around the earth at twenty thousand dollars a mile. It would build a hundred thousand churches, each costing ten thousand dollars, or half a million school-houses, each costing two thousand; or it would employ a million of preachers and a million teachers, at a salary of five hundred dollars."

It is estimated by a computation from internal revenue tax paid in the fourth district of Michigan, that the consumers of tobacco in that district in one year paid out ten times the amount it costs per annum to support the University of Michigan and its students.

The late President Wayland says: "The American Board, an institution of world-wide benevolence, which collects its funds from all the northern states, does not receive annually as much as is expended for cigars in the single State of New York." But this is not the only expense of tobacco using. Great fires often result from the carelessness of smokers. A plumber threw down a lighted match in the printing establishment of Harper Brothers; a fire resulted with a loss of two million dollars, and about two thousand people were thrown out of employment. A fire which destroyed three million dollars' worth of property resulted from the throwing away of a half-smoked cigar. A young woman was riding

with a young man who was smoking; a spark from his cigar set fire to her light muslin dress, and she was burned to death.

The destructive effects of tobacco-raising on the soil must be included in this count of cost; also its effect upon the condition and character of those raising it. Jefferson says: "It is a culture productive of infinite wretchedness. No other crop so entirely exhausts the soil, and this must be recognized by those who travel through the old tobacco-growing districts."

Close observers declare that the cultivation of tobacco tends to blunt the moral and religious sensibilities, impairs the spiritual perception, and results in many cases in spiritual death. If tobacco lessens courage, decreases will power, diminishes mental force, and deteriorates bodily vigor, its constant use, as in our country, cannot fail to be manifest in the characteristics of the nation.

Extracts from the *Quarterly Journal of Science*, 1873: "Homer sang his death song, Raphael painted his glorious Madonnas, Luther preached, Guttenburg printed, Columbus discovered a new world before tobacco was heard of. No rations of tobacco were served out to the heroes of Thermopylæ, no cigar strung up the nerves of Socrates. Empires rose and fell, men lived and loved and died during long ages without tobacco. History

was for the most part written before its appearance. 'It is the solace, the aider, the familiar spirit of the thinker,' cries the apologist; yet Plato, the divine, thought without its aid, Augustine described the glories of God's city, Dante sang his majestic, melancholy song, Savonarola reasoned and died, Alfred ruled wisely without it. Tyrateus sang his patriotic song, Roger Bacon dived deep into nature's secrets, the wise Stagirite sounded the depths of human wisdom, equally unaided by it Harmodius and Aristogeiton twined the myrtle round their swords and slew the tyrant of their fatherland without its inspiration. In a few words, kings ruled, poets sang, artists painted, patriots bled, martyrs suffered, thinkers reasoned before it was known or dreamed of."

CHAPTER VI.

THE FOE OF THE HOUSEHOLD.

I ONCE invited a lady to visit me in my new house which had been built after my own plan, and was very dear to me. She brought with her a little son of five years, and he had a most enjoyable time even if I did not. He made pictures on the windows with moist fingers; he swung from the door-knobs, kicking the paint with his heels; he drew pictures on the dainty paper with a pencil; and, finally, he lay down on the floor and pounded with his heels on the wall; to enjoy the noise, I suppose. When told by his mother to stop injuring the house he exclaimed: "Well, what are houses made for then?"

When I have seen the evident delight taken by people in the wilful destruction of their bodies, I have thought that, like this child, they imagined their bodily houses were made to destroy.

There is one guest who is as destructive, though not as frank a visitor, as this child. Like the other false friends whom we have described, he claims to build up while in reality he is only pulling down. He poses as a royal individual

under the title of King Alcohol, and many of his subjects do him loyal homage. Although claiming the title of royalty, he proffers invaluable service. He says: "Admit me to your house and I will add to its powers and increase your happiness. I will give you added digestive force, and increase your mental ability and muscular vigor; I will enable you to endure cold, hunger and hardships; I will cure your diseases, quiet your pains, and comfort you in your sorrow."

No wonder that with such promises he was believed to be a veritable saviour from manifold ills, and, as such, was received in the palaces of the rich and the cottages of the poor with a right royal welcome.

And how has he kept his promises? For a long time it was supposed that he actually did all that was claimed for him: songs were sung in his praise, and in homes and hospitals, in health and disease, accidents and emergencies, he was thought to be the one unfailing reliance.

Before we study his deeds, let us learn a little of his personality. The forms under which he asks admission to the bodily house are many. Sometimes he comes as a right jolly, commonplace fellow called Beer, who hobnobs with those whose purse is slim and whose tastes are for ordinary pleasures. Sometimes as Cider he

claims to be the companion of rustic enjoyments. To the more refined and fastidious he presents himself as bright, sparkling Wine, that claims only to exhilarate and enhance the joys of life. Sometimes in the guise of Brandy, Whisky, Gin, and the like, he makes a sharp appeal to the senses, and more quickly deadens the sensation of discomfort.

Science, in her investigation, has learned that decomposition is taking place constantly; that substances are changing their forms, but that in all the change nothing is lost. All organized substances undergo the form of decomposition called decay, and the decay of the same substance under different circumstances gives rise to different products. Nitrogenous compounds decay very readily. Pure starch and sugar will keep a long time, but brought into contact with nitrogenous products in the process of decay, they will take on the same condition. We know that one decayed apple in a basket will very soon spoil all the rest, and we are not very fond of rotten fruit. This process of decay is accompanied by what is known as fermentation, where the substances are broken up into carbonic acid and water. It is now conceded by scientists that in all these processes of decay living organisms, known as bacteria or ferments, are present. In the production of Alcohol there must be five things: First,

sugar; second, water; third, heat; fourth, a ferment; and fifth, atmospheric air. The juices of vegetables and fruits contain sugar and water; bacteria are always found in the air: hence these juices exposed to the air in a warm place ferment and produce alcohol.

All grains have a great deal of starch which can be changed into sugar. In the sprouting of all seeds a peculiar ferment called diastase is produced. When grain that has sprouted is killed by hot water and allowed to stand a short time, this ferment increases and thus produces what is known as malt, which, added to another grain and kept moist and warm, will change its starch into sugar, and then the fermentation takes place which produces alcohol.

You see that in order that alcohol may exist, the sweet, nourishing grain must die and rot, and all its health-giving properties be destroyed Beer is made from the fermentation of barley; wine is the fermented juice of grapes or other fruits; hard-cider is the fermented juice of apples. By the action of heat, alcohol is driven off from these fermented liquors, and this is called distillation. In the process some water goes off with the alcohol and thus is formed various strong liquors, such as brandy or whiskey, which are one-half alcohol. Some wines are one-fourth alcohol,

others not more than one-twentieth; cider is, perhaps, one-fifteenth. Count Chaptal says: "Nature never forms spiritous liquors; she ripens the grape upon the branch, but it is art which converts the juice into wines." Hargreave's book, "Alcohol and Science," says: "No chemist has ever yet found alcohol among the substances formed by plants. Nature, in the laboratory of vegetation, takes the poisonous gases and splits them up, and then puts the atoms into new groups capable of nourishing the animal system. But alcohol is a product of dissolution, the wreck, the disorganization of human food; it is, in reality, a product of decomposition. The juices of the fruits, by the influence of that fungus yeast, are turned into rottenness, and then, and then only, is alcohol generated out of the destruction of the organic sugar. It has the same origin as the malignant and fatal exhalations of pestilence, the putrefaction of organic substances. Hence, it is no more the gift of the Creator than is the malarial poison that breathes its contagion and strikes down the young and old with disease and death."

Sometimes a housekeeper finds a can of fruit that has spoiled, or "worked," perhaps she says, as she throws it away, recognizing it as not fit to be eaten. The "working" is the process of fermentation, and wine or hard-cider is also spoiled

fruit-juice and is no better for use than the can of fermented fruit.

To continue life in the body we must take into it the products of life. Alcohol contributes no substances that form tissue, and when eliminated from the excretory organs it is still alcohol. It is thrown out through the pores of the skin, through the lungs and the kidneys. Dr. Ogsden of Aberdeen examined the body of a woman who died while intoxicated, and found in the heart nearly four ounces of fluid having all the qualities of alcohol. Dr. Percy of Nottingham, England, had no difficulty in extracting alcohol from the blood, from the substances of the brain, from the liver and the bile. It must not be supposed, however, that Alcohol leaves the body just as he found it. Everywhere he goes he leaves traces of his destructiveness. In the first place, he is a thief of water, and begins his robbery as soon as he enters the house. He takes water away from the mucous membrane of the mouth, giving a puckered feeling, more or less severe, according to the dilution of the alcohol. This abstraction of water takes place throughout the body wherever Alcohol goes.

The question is asked, "Is not alcohol in some sense a food and therefore of value?" In reply let us ask and answer another question. What is a food? Dr. Victor C. Vaughn, of the University

of Michigan, defines food as "Any substance which aids in building up or repairing tissue, or adds to the sum total of energy liberated in the body in a given time."

How far does alcohol answer these requirements? In the first place, we recall that nitrogen is absolutely essential to the building up of tissue. Alcohol contains no nitrogen, so it cannot be a food in the sense of formation or repair of tissues.

Energy manifests itself in the body in the form of heat or activity. It is often claimed that alcohol warms people, but close observation proves that this is not true, that the warmth is only in seeming. By paralysis of the vaso-motor nerves, which govern the size of the blood vessels, a greater amount of blood goes to the capillaries, and the individual feels a sensation of warmth, but the clinical thermometer will at the same time show that the temperature is actually lowered. The experience of Arctic explorers demonstrates that alcohol diminishes the power of enduring extreme cold. Sir John Richardson, M. D., of the English Arctic expedition, says: "I am quite satisfied that spiritous liquors diminish the power of resistance to cold. Plenty of food and sound digestion are the best sources of heat." The experience of twenty-six men traveling in the far West, well provided with food, clothing, and

whiskey, but with no means of building a fire, illustrates the deceptive nature of alcohol in keeping men warm. Their experience was severe, and those suffered most who drank most. Those that became intoxicated froze to death; those that drank less lived through the night, but died after a time; those that drank moderately survived, but will feel the effects of their experience as long as they live. The three men who survived without any serious effects were the three, who, through the whole time, never drank a drop. These men were all Americans between twenty-three and forty-one years of age; all were equally provided with blankets; all were in good health, the only difference being in the amount of liquor which they used.

In the experiments made to discover whether alcohol is in any sense a food it is found that while most of it is thrown out unchanged, a certain small amount may be taken in twenty-four hours and not make its appearance in the excretions: that is, it disappears in some way and cannot be accounted for. From this fact some physiologists argue that it is oxidized in the body and therefore becomes a source of strength, and claim that this amount of alcohol in twenty-four hours is a benefit, but more than this is an injury. If it really is oxidized we would expect to see the

effects in an increase of strength in some way, but the more we investigate the more we meet the proof that alcohol in any amount, small or great, adds nothing to the power or ability of the individual.

The great Powers of the world are beginning to realize this. By order of Field-Marshal Lord Wolseley, the commander-in-chief of the British Army, careful and exhaustive experiments have been made to learn the relative effects of alcohol and of total abstinence upon the physical endurance of the troops. One regiment would be deprived of every drop of stimulant. Another, belonging to the same brigade, would be allowed to purchase its malt liquors as usual, and a third would receive a sailor's ration in the form of whiskey.

"In each instance, the experiment went to show that, whereas at first, the corps which had received an allowance of grog surpassed the others in dash and in impetuosity of attack, yet that, after the third or fourth day, its members began to show notable signs of lassitude and a lack of spirit of endurance.

"The same manifestations, though in a minor and slower degree, were apparent in the regiments restricted to malt liquors, whereas the men who had been kept from every kind of stimulant

increased in staying power, alertness and vigor every day.

"The result of these experiments led the British war department to decide, not on the ground of principle, but solely for the sake of maintaining the powers of endurance of the troops engaged in the Soudan campaign, not to permit a single drop of stimulant in camp save for hospital use.

"The scheme has fulfilled all expectations. Thanks to total abstinence, the men have been able to make forced marches of the most extraordinary character across the burning desert and under a blazing sun, the heat of whose rays can only be appreciated by those who have lived under the equator."

The United States has long since prohibited the daily ration of liquors to the men in the navy, and forbids the use of stimulants at sea. The British have not gone as far as this, but orders have been recently issued to the commander of all British men-of-war in commission that, in place of the double rations of grog formerly served out to the crews when going into action, not a drop of alcoholic liquor, no matter whether spirit, wine, or malt, is to be allowed when there is any fighting to be done. They are, however, subject to no such restrictions when engaged in mere manœuvers or gunnery practice.

In an official report of prize-firing of battleships of the British Mediterranean Squadron, one ship, the "Royal Oak," hit the target only four times in seventy, while the "Ansen" failed to make a single hit in twenty rounds.

Had the American Squadron, under Admiral Dewey at Manila, done no better than this, there would not have been so overwhelming a victory. Each projectile from his guns seems to have hit its mark, if we may judge from the annihilation of the Spanish fleet. May not the total abstinence enforced upon United States men-of-war have had much to do with the superiority of American gunnery? And may not the poor marksmanship of the Spanish be accounted for by the fact that they, as do the French, German, Russian and Italian navies, retain the habit of doubling the allowance of wine or spirits when going into action.

Not only have governments been closely observing the effects of alcohol, but business corporations have turned their attention in the same direction. Not long ago a large railroad company investigated the conditions that existed in every accident that had occurred on its lines during the preceding five years. It was found that forty per cent of all accidents was due entirely, or in part, to drinking men. Railroad corporations are beginning to prohibit the use of alcohol by their

employees, realizing that the men in their employ especially need delicacy of touch, keenness of vision, and acuteness of judgment, all of which are impaired by the use of alcohol even in moderate quantities.

Experiments made upon a number of individuals reported by Dr. J. W. Grosvenor at the annual meeting of the American Medical Association, prove that under the influence of two drams of alcohol the sense of feeling is diminished from ten to fifteen per cent. The sense of vision is diminished about eleven per cent. The ability to judge between weights requires acute perceptive faculties and this is lessened about thirty per cent by the same amounts of alcohol.

Everywhere through the house Alcohol goes with the blood into all the minute capillaries. It may cause the little red corpuscles to cling together in clots, and these clots may lodge somewhere in the blood vessels, stopping the circulation through that part and causing it to die; or they may go to the lungs and stop the circulation there; or to the heart and prevent its action; or to the brain and produce apoplexy. Alcohol changes the shape of the red corpuscles, and interferes with their power to carry oxygen to all parts of the body.

But alcohol helps digestion, you say. What is

the report of Science on this point. Dr. Beaumont again gives us valuable information. He observed that whenever St. Martin drank any alcoholic beverages, whether it was beer, wine or stronger drinks, the coat of the stomach became inflamed, and when he had been drinking freely for some days there were ulcerous patches which increased with the amount of drink.

People sometimes say they are sure that alcoholic drinks do not hurt them because they are not conscious of any disturbing effect; but even when Dr. Beaumont saw these ulcerous patches in the stomach of St. Martin, the man himself had no pain. If the doctor had judged by St. Martin's feelings, he would have said no harm was being done; but the stomach told another story. When liquor was abandoned, the stomach was gradually restored to the healthy state. Dr. Beaumont says: "It was not ardent spirits alone that produced these changes, but even wine and beer. Nor are these changes indicated by any ordinary symptoms, or particular sensations; their existence was only ascertained by ocular demonstrations."

But if a stomach, inflamed by alcohol, should complain, the man usually argues that it is a call for more drink. If he takes the drink, he feels the gnawing lessened, and then argues that the

drink is beneficial. The truth is that the alcohol deadens the sense of discomfort by a partial paralysis of the nerves of sensation, and as soon as they have recovered from this paralysis, the feeling of uneasiness returns. This process repeated year after year may result in a serious disease, perhaps even in cancer.

Alcohol not only irritates the mucous membrane of the stomach but it precipitates the pepsin. What does that mean? Well, it means this: There is in the gastric juice an active substance called pepsin which has the power to digest food. When alcohol is taken, it causes this pepsin to separate from the gastric juice, to settle as a sediment, and to lose its active power. It is as if it took the knives and other culinary utensils out of the hands of the cook, threw them in a heap on the floor, and claimed that that was helping the cook to do his work.

Dr. J. H. Kellogg, in his studies of the effects of various substances on the process of digestion, finds that alcohol always hinders stomach digestion. From his experiments he learned that less than an ordinary tablespoonful of claret taken with a full meal lessened the digestive power nearly four per cent. Three tablespoonsful of Toledo, Milwaukee or New Haven beer retarded digestion to a very marked degree. These inves-

tigations of Dr. Kellogg have not been chemical experiments conducted in a laboratory, but are *vital* experiments upon actual digestive processes as explained in the chapter on Spicy Visitors.

The effect of alcohol on the heart is marked. It interferes with its steady pumping, the action becomes more and more rapid, therefore time for rest is lessened, and this wears the heart out faster than is necessary. Experiments have proven that if a man drinks only one fluid-ounce of alcohol a day, his heart will, during that time, beat four hundred and thirty times oftener than it does normally, and eight ounces will cause it to beat about twenty-five thousand times oftener than it should. Even two ounces of alcohol, evenly distributed throughout the day, will raise the number of heart-beats by about six thousand in twenty-four hours. The increased rush is partly due, also, to the paralyzing of the nerves of the capillaries and partly by the paralyzing of the nerve the office of which is to slow the action of the heart.

This increased rapidity of the heart's action is accompanied by an even greater diminution of power. Experiments conducted by Professor Martin of Johns Hopkins University proves that even so small a quantity as one-half of one per cent of alcohol in the whole volume of the blood diminishes the work done by the heart to such a

degree that the left ventricle will not send out blood enough to supply the arteries that go to nourish the heart itself. This most clearly proves that alcohol is not a heart tonic.

The kidneys are seldom found in a healthy condition in a drunkard, or even in a moderate drinker. Dr. Christison, of Edinburgh, says that nearly four-fifths of the cases of kidney diseases with which he has had to deal were in persons who were real drunkards, or else used alcoholic liquors constantly, though, perhaps, never becoming really intoxicated.

The liver is the organ first affected by the use of alcohol. It becomes greatly enlarged in size through being loaded with fat. We have studied the wonderful work done in the liver and can readily understand that if its healthful action is interfered with, the whole body is more or less disturbed. Alcohol changes the secretion of bile from a bright yellow color to green, or almost black, and from a thin fluid to one the consistency of tar. It hardens the liver tissue until, as Hargreave says: "The liver sometimes becomes full of unabsorbed matter which forms in spots and consists of a kind of consolidated pus, such as is seen to form under a scab, or when an ulcer is opened. These little spots at first may not be larger than a pin-head, but as the inflammation

increases, two or more unite to form a larger spot, and these grow until at last the whole liver is changed in color." Poultry dealers sometimes mix alcohol with the food of fowls in order to increase the size of their livers. The examination of drunkards after death discloses horrible things concerning the effect of alcohol on the liver. Sometimes it is covered with tubercles, and the blood vessels are entirely destroyed, showing that circulation had ceased even before death. Sometimes the liver is covered with lumps, sometimes with fungus growths. This increase of the size of the liver, together with the stretching of the stomach in men who drink large quantities of beer, changes the beautiful outlines of the body, and they become coarse and unsymmetrical, and yet although the external appearance may indicate unhealthful conditions, the individual may feel no pain.

Dr. Trotter says of chronic disease of the liver that it is not painful, is slow in its progress and frequently gives no alarm until some incurable affection is the consequence; so that the liver and stomach of the moderate drinker may be seriously diseased while the man imagines himself to be in good health.

But we have not yet recited all the evil effects of alcohol. It is carried to the brain through the

circulation and there sets up its peculiar poisonous action, paralyzing the nerves, and, to a great extent, destroying the substance of the brain itself. We remember that the brain is of a jelly-like consistency, and we learn that all the substances of which it is composed, except its albuminous frame-work, are soluble in warm alcohol; so that the brain of the drinker becomes smaller and harder, and less capable of doing its desired work. As a result, we may have the production of apoplexy, epilepsy, insanity or imbecility.

Dr. Pliny Earle, of the Lunatic Hospital, Northampton, Mass., says: "There are at least five distinct varieties of mental derangement which own alcoholic intemperance as their direct and efficient cause."

Alcohol is a most effectual destroyer of the power of self-control. As Dr. Kerr says: "The shiftless, unstable victim is tossed about on the ocean of inebriate excitation like a rudderless ship in a storm." It is the strong man who refrains, the weak man who yields. Alcohol is sometimes taken under the supposition that it increases mental power. It is a physiological fact that one-fifth of the blood is circulating continuously through the brain, and we remember that alcohol in the body undergoes no change but remains always alcohol. We see then that one-fifth of the

alcohol that is in the whole amount of the blood must be in the brain and we begin to wonder what will be the effect on the brain cells. Dr. T. D. Crothers says that in small quantities alcohol excites, that is, irritates these cells, and that large amounts so paralyze that the gray cells are incapable of performing their functions.

Other scientists claim that alcohol never stimulates but depresses the central nervous system, and they explain the symptoms of excitement as not due to stimulation but as the result of the weakening of the will, the lessening of the power of self-restraint.

Dr. Cushing says: "The latter theory seems the more satisfactory, for there is evidence on every hand that even the smallest quantities of alcohol tend to lessen the activity of the brain. It would seem to act most strongly, and therefore in the smallest quantities on the most recently acquired faculties, to annihilate those qualities that have been built up through education and experience, the power of self-control and the sense of responsibility." This learned man asserts that the evidences of the depressing action of alcohol on the brain are embarrassing by their number. Soldiers can march longer without it, typesetters can do more work and make fewer errors : all forms of mechanical work are hindered by its use.

Kraepelin found in a series of careful experiments that the powers of intellect were weakened, and he decides that alcohol does not add to the ability to work or to think.

The man who has taken alcohol will talk wildly, without reason; in fact, will be temporarily insane because the speech centers are affected. He will be unable to walk straight, for the cells that preside over the motor functions are paralyzed, and this paralysis explains why he will also have a lessening of sensation and of the powers of sight and hearing. If he takes still larger amounts the paralyzing influence may extend to the centers that govern breathing and circulation and he dies from alcoholic poisoning. It is really coming very near the truth when we speak of a man as "dead drunk," for in that state he is so completely paralyzed that his condition is a very dangerous one.

In alcoholism, death takes place, Dr. Crothers assures us, when there is one part of alcohol to one hundred of blood.

In our study of the telegraph, we saw that certain parts of the brain control certain portions of the body, and it is now conceded that one part of the brain is intimately connected with the digestive apparatus. This is shown in the recognition of the necessity for food. This brain center, repeat-

edly irritated and poisoned, creates a false appetite which calls for the paralyzing effect of the same substance that has produced the evil. If the use of alcoholic liquors is begun in youth, the effect is just so much the more injurious; and we have the testimony that in beer-drinking countries the habit of alcoholic liquors among children is continued even to the production of drunkenness.

So alarming has been the increase of drunkenness among children attending school in Austria, that the Vienna school-board have been making an effort to induce the government to prohibit the sale of liquors to children under fifteen.

In England, it is reported that children of seven years old have been treated for delirium tremens. Dr. Kerr relates several cases of delirium among children, saying that babies of not more than two years of age would cry for their daily allowance of spirits. He also asserts that the use of wines for breakfast and dinner by children is leading to inebriety.

Everything that lessens nutrition and depresses physical powers paves the way to indulgence in alcohol. So, bad air, impure food, overwork and mental strain may be classed as provocative of the use of alcohol. On the other hand, we may enumerate pure air, good food, cheerful surround-

ings and exercise as among the most valuable remedies, and, better still, as preventives.

The same plea is made for alcohol as for tea and coffee: that it checks waste, and therefore is an indirect food; but we may again bring as counter argument, the statement that the checking of normal waste is not desirable.

Dr. Campbell, of Edinburgh, says: "It seems to me a remarkable fallacy that physiologists should persist in talking of the propriety of sparing tissue, inasmuch as the proper function of tissue is its destruction, and life the resultant of the change. Indeed, when any tissue is unduly retained in the system, it may of itself constitute the material of disease."

All the activities of life result in destruction of tissue, and this creates a demand for the material of which new tissue can be formed. This is why exercise makes us hungry. We should not be so anxious to prevent waste of tissue as we should be to see that all waste is duly eliminated and the destruction repaired by the digestion of wholesome food.

One of the strongest evidences that alcohol is a destroyer of life is found in the statistics of the mortality of drinking people compared with that of abstainers.

Life insurance companies will not insure the

lives of intemperate people, but they will insure moderate drinkers. The Temperance Provident Institution insures no one but total abstainers, and from the statistics of this society it seems that total abstinence from alcoholics reduces the death rate at least one-half.

Some years ago Mr. Locke, better known as Petroleum V. Nasby, caused the physicians of the city of Toledo, Ohio, to be interviewed in regard to their opinion of alcohol. The universal statement was against its use. One physician had especially noticed the sudden death of men in the prime of life, who outwardly bore a healthy appearance and yet suddenly fell victims to pneumonia, apoplexy, heart difficulty, or Bright's disease, and observed that they were principally drinkers of beer. An army surgeon said it would be difficult to find any part of a beer drinker's machinery that is doing its work as it ought. Medical men dread even moderate drinkers as patients. Surgeons learn that men who are in the habit of using alcoholic beverages will not easily recover from even slight surgical operations.

As alcohol is supposed by many to be a specific remedy in cholera, it might be interesting to study the testimony of physcians on this point. Hargreaves says : "Alcoholics tend to produce a condition in the system resembling cholera by

changing the arterial blood into venous without the substance of the tissues having taken any share in the transformation."

A Warsaw physician says concerning an epidemic of this disease: "Cholera, up to the present period, has respect for persons who lead regular lives, and has struck without pity every man worn out by excess and weakened by dissipation." Professor Mackintosh says: "It has been computed that five-sixths of all who have fallen by cholera in England were persons of intemperate habits."

The cultivation of vineyards and the manufacture of wines are advocated by some as a means of preventing drunkenness, but observation of wine-drinking in various countries proves this to be a mistake. All wines have a greater or less amount of alcohol in them, and many wines are made so strong by the addition of an extra quantity of alcohol that they are almost equal to distilled liquors. They tend to the production of all the diseases which alcohol can produce.

In view of all that we have learned of the effects of alcohol on the system, we begin to wonder what its value may be in the treatment of disease. It was once believed to be a veritable panacea for all human ills: was called, indeed, *Aqua Vitæ*, or water of life. It was found in all domestic medi-

cine chests and prescribed by all physicians who judged of its probable value solely by the sensations and actions of the patient. These patients felt less pain, appeared more lively, the heart beat more rapidly and so the doctors said it was a good thing. Because people took alcohol and lived, they said it was a food; because the heart beat faster, they said it was a heart tonic; because the patient seemed more lively, they said it was a stimulant. Now we learn that in wasting diseases it can add nothing to the building up of tissues; therefore, it is not a direct food. Its claim that it is an indirect food rests upon the fact that it lessens the distribution of oxygen and all the processes of waste are lessened; but this lessening of molecular changes is accompanied by the lessening of nutrition as well as of waste, and also by fatty degeneration, which certainly is not desirable. The tissue-cells are degenerated, the activity of the white corpuscles decreased, and as these white corpuscles are the guards which destroy poisons and hurtful substances in the body, to lessen their activity is to do harm.

It has been thought to be a tonic, but as it lessens the excretions of poisonous elements which should be eliminated and allows the accumulation of waste products in the system, it is difficult to see how it can at the same time give

strength and tone. It is now known that in convalescence from fevers or other long illnesses alcohol is no helper in recovering strength.

Its apparent effect as a heart tonic rests upon the fact that it paralyzes the nerves that govern the regularity of heart-beats before it does those that stimulate it to action, so it at first beats more rapidly, and then more feebly.

Dr. Crothers says: "The fact is that alcohol is ceasing to be used as a medicine because its real action is becoming known. Facts are accumulating which prove that it is always and everywhere a depressant and narcotic, that it cannot build up tissue, but always acts as a degenerative power, and that its apparent stimulating effects are erroneous and misleading."

Believing that the scientific discoveries of to-day are more to be trusted than the mere superficial observations of the past, we must believe that alcohol has little or no place in the treatment of disease.

The loss to the nation through alcohol can scarcely be estimated. We are told that in the United States one hundred thousand persons die every year as drunkards. It is calculated that for every death there are fifty cases of illness. Add to this the loss of life resulting from the frenzy of intoxication or from the inefficiency of drunken

men in responsible positions; of children mutilated or crippled or smothered accidentally by drunken parents, and the loss becomes appalling.

The extravagant expenditure of money is also a question seriously to be considered. It is estimated that nine hundred million dollars a year is expended in the purchase of alcoholic beverages and that it costs the United States not less than sixty million dollars a year to support pauperism and crime, produced mostly by alcohol. Penetentiaries, reformatories, jails and inebriate asylums are all sources of expenditure which would be greatly lessened if total abstinence prevailed. I shall only be able to indicate in these pages a very small amount of the actual evils caused by the use of alcohol.

If men came into our house, no matter how elegantly dressed or with what polished manners, and at once began a destruction of our most precious treasures, even of our dwelling itself, it would not take us very long to rid ourselves of the intruder.

When we look over the charges brought against this titled adventurer, King Alcohol, when we see that from the very first moment of his entering our bodily dwelling, he begins his work of destruction and continues it in all parts of the body, tearing down, destroying, paralyzing and utterly

ruining, I think we will all agree that we would be showing ourselves wise if we set ourselves firmly to oppose the admission of Alcohol in all forms and under every disguise, never suffering ourselves to be deceived by his pretensions, but accepting as true the Biblical statement: "Wine is a mocker, strong drink is raging; and whosoever is deceived thereby is not wise."

AIDS TO TEACHERS AND SCHOLARS.

PART I.

QUESTIONS ON CHAPTER I.— PAGE 13.

1. How many people have you ever seen in your life? 2. How do we know people? 3. How do our bodily houses differ? 4. When did you enter your bodily dwelling? 5. Who entered it at the same time? 6. How much interest should you take in your body? 7. Who was the architect of your bodily house? 8. Where is the Taj Mahal? 9. How many workmen did it take to build it? 10. How many years? 11. What did it cost? 12. What is it? 13. What house is more beautiful than the Taj Mahal? 14. What is the body besides a dwelling? 15. How does man become acquainted with the outside world?

QUESTIONS ON CHAPTER II.— PAGE 17.

1. Did you ever see a house walk? 2. How many stories has our bodily house? 3. What wonderful things can it do? 4. Of what is it made? 5. What is the material of which it is

made? 6. What shape are the bones? 7. When united what do they form? 8. What is the upper story of the bodily house? 9. What is the third story called? 10. What are the beams? 11. How many? 12. What tower supports the upper story? 13. What is the second story called? 14. What is the lowest story? 15. What is attached to this? 16. How many columns has our bodily dwelling? 17. What is its purpose? 18. How is it composed? 19. Why is the spine curved? 20. How are the arms and legs attached to the body? 21. What is a hinge joint? 22. What is a ball and socket joint? 23. What is bone made of? 24. How can we destroy the animal matter of bone? 25. How can we destroy the earthy matter of bone? 26. Why do the bones of old people break more easily than those of children? 27. How do the flexible bones of the baby change to the hard bones of the man? 28. What is the shape of the long bones at the end? 29. What holds them together? 30. How are the bones oiled?

QUESTIONS ON CHAPTER III.— PAGE 27.

1. What is staff? 2. Of what are the walls of our bodily house made? 3. What are muscles for? 4. What do we find in a Swedish movement room? 5. What is the first property of muscle? 6. How can you illustrate it on yourself? 7. With what force do muscles contract? 8. What is the seeond property of muscle? 9. What does this mean? 10. What is the third

property of muscle? 11. Why is this important? 12. Why are not muscles laid in flat masses over the framework? 13. Of what are muscles made? 14. Of what are fibres made? 15. What is a fibril? 16. What is the difference between fibres of thread and fibres of muscles? 17. How are muscles held together? 18. What is the use of fat? 19. What is the shape of muscle? 20. What is a tendon? 21. How many muscles are there in the body? 22. How do they work? 23. Which are the flexor muscles? 24. Which the extensor? 25. How many muscles are needed to turn the eyeball? 26. How many are there in the arm and hand? 27. Which muscles are striped? 28. Which are unstriped? 29. What muscle lifts the upper lip? 30. Which one puckers the forehead? 31. What is the proper attitude in standing? 32. What causes round shoulders? 33. How can they be prevented or cured? 34. How can you tell whether you stand in a correct attitude or not? 35. What is the advantage of standing correctly?

QUESTIONS ON CHAPTER IV.— PAGE 45.

1. What is the sheathing of our wonderful house? 2. What is the outer layer called? 3. What is beneath this? 4. What runs through the dermis? 5. What is the difference between the work of man and the Divine Architect? 6. How is our bodily house painted? 7. What is the office of the skin?

QUESTIONS ON CHAPTER V.— PAGE 48.

1. What is an important part of very modern houses? 2. What goes through muscles, bones and skin? 3. Why does pricking you with a pin draw blood? 4. What are the sweat glands? 5. How long are they? 6. How far would they reach laid end to end? 7. What is perspiration? 8. What is insensible perspiration? 9. How much does it amount to in 24 hours? 10. How much does exercise increase it? 11. Why are we thirsty? 12. Why should we bathe frequently? 13. How soon after eating should we bathe? 14. Why is it dangerous to go swimming soon after eating? 15. Why should feeble persons rest after a bath? 16. Who may exercise after a bath? 17. Why not bathe when exhausted? 18. What should be the temperature of the bath room? 19. What should follow a hot bath? 20. Why? 21. When is the best time of day to bathe? 22. What is the effect of rubbing the skin with oil? 23. What is the effect of dry rubbing?

QUESTIONS ON CHAPTER VI.— PAGE 53.

1. What is a thatch? 2. Has our bodily house a thatch? 3. What makes the color of the hair different in different people? 4. What causes gray hair? 5. What keep hair oily? 6. What belongs to each hair? 7. Why does it hurt when your hair is pulled? 8. What makes the hair stand on end? 9. Prove that hair is elastic.

10. How strong is hair? 11. Where is hair found? 12. What are finger nails? 13. Of what use are they? 14. Why should we take care of them?

QUESTIONS ON CHAPTER VII.— PAGE 56.

1. What part of our bodily house is called the cupola? 2. What shape is it? 3. How is it covered? 4. Roofed? 5. How many windows? 6. How can we see on all sides? 7. What is there above each window? 8. What is its use? 9. What is there between the windows? 10. Who goes in and out of these doorways? 11. What is there below the portico? 12. What are there on the sides of the copula? 13. How does man become acquainted with the world? 14. If his windows are broken what happens? 15. How does man injure his eyes? 16. How many bones in the framework of the copula? 17. How are they joined together? 18. What are the characteristics of the outside layer? 19. Of the inner layer? 20. What is between these? 21. What membranes line the inside of the copula? 22. What is the outside membrane? 23. What is the outer one of the three called? 24. The middle one? 25. Why? 26. The inner one?

QUESTIONS ON CHAPTER VIII.— PAGE 61.

1. What is the room inside the copula called? 2. What is in this room? 3. What does the French writer call it? 4. What is the brain like?

5. What is the average weight of human brain? 6. Of what is the brain composed? 7. What are the convolutions? 8. How is the brain divided? 9. Where is the great brain located? 10. The smaller brain? 11. What connects the two brains? 12. Of what is the brain made?

QUESTIONS ON CHAPTER IX.— PAGE 64.

1. What folding doors are there on the front of the copula? 2. What closes them? 3. What can these doors do? 4. Where do we find mucous membrane? 5. What is its purpose? 6. When guests enter through the pink folding doors who receives them? 7. Are there always 32? 8. Are they always dressed in white uniforms? 9. Where are these attendants in little new houses? 10. How many of these? 11. What do they do when they want to see the world? 12. What happens after six or seven years? 13. What are the front centre teeth called? 14. What is the long sharp one on each side of these? 15. What are the bicuspids? 16. Why are they so called? 17. What are back of these? 18. Do the teeth need to be used? 19. What should be done to keep them in good health? 20. How may they be injured? 21. What guard occupies the reception room? 22. What is his business? 23. Is he to be fully relied upon? 24. What affable attendants are in the reception room? 25. What is their business? 26. What is the roof of the reception room called? 27. What is at the back of this room? 28. What is its purpose? 29. What is the hall? 30. What

is its peculiarity? 31. What passages lead out of it and where? 32. Where are the kitchen stairs? 33. What is peculiar about them? 34. Why can we swallow a large mouthful more easily than a a very small pill?

QUESTIONS ON CHAPTER X.— PAGE 71.

1. What do we find at the bottom of the kitchen stairs? 2. How large is the kitchen? 3. What is the kitchen? 4. How many muscular coats has it? 5. How do the fibres run? 6. Why? 7. Who is the cook? 8. What is his work? 9. Why is it injurious to drink cold water while eating? 10. What is the effect of eating too much? 11. Of eating between meals? 12. What door leads out of the kitchen? 13. What is vomiting? 14. When does it occur? 15. Of what is food made, chemically speaking? 16. Can we live on these elements? 17. Where does man obtain these elements? 18. What are proteids? 19. Where is gluten found? 20. Legumin? 21. Casein? 22. Myosin? 23. Why do we eat a variety of foods?

QUESTIONS ON CHAPTER XI.— PAGE 76.

1. What is the Latin name for the second kitchen? 2. Why is it so called? 3. What assistants work in this second kitchen? 4. Who is the most important helper? 5. What does he do? 6. Where does bile come from? 7. What is the work of the bile? 8. What are in the walls of the butler's pantry?

QUESTIONS ON CHAPTER XII.— PAGE 79.

1. What opens out of the butler's pantry? 2. How long is the dining room? 3. What are its muscular coats? 4. What is the first eight feet of the small intestines called? 5. Why? 6. What is the rest of it called? 7. Why? 8. Where are the intestines located? 9. How are they held in place? 10. Where are they fastened? 11. Why are there folds on the inside of the small intestines? 12. Who is the head waiter? 13. Who are his assistants? 14. Who eat the dinner? 15. Why are the eaters always in the dining room and what are these little eaters called? 16. In what condition is their food? 17. What is chyle? 18. Of what are our bones and flesh made? 19. How does the food get into the blood? 20. What are the lacteals? 21. What are the lymphatic glands? 22. How many are there? 23. What is the *receptaculum chili?* 24. What changes come to the chyle in passing through the lymphatic glands? 25. What do they carry? 26. What is the colon? 27. Where is it located? 28. How long is it? 29. What results from the peculiar arrangement of its muscular fibres?

QUESTIONS ON CHAPTER XIII.— PAGE 86.

1. What is in the very center of our bodily dwelling? 2. How can you find out where your heart lies? 3. Why do you think it is on the left side? 4. How fast does the heart work? 5. Where can you feel your pulse beat? 6. What

is the heart? 7. When does the heart rest? 8. How much of the time does it rest? 9. How is the heart divided? 10. What incloses the heart? 11. What is the auricle? 12. What is the ventricle? 13. What closes the opening between the auricle and the ventricle? 14. How much work does the heart do in 24 hours? 15. How much of the body weight is blood? 16. How long does it take for the whole amount of blood to go through the heart? 17. How much does the heart of the ordinary man hold? 18. How many tons would his heart pump in 24 hours? 19. What is a foot pound? 20. Lifting one pound 16 feet high is the same as what? 21. How high would the blood jet at each stroke if there were no walls to confine it? 22. In 72 heart beats how much force is used? 23. In 24 hours how much? 24. Why are the walls of the left ventricle stronger than the right? 25. Why should we exercise? 26. Why should we lie down to rest?

QUESTIONS ON CHAPTER XIV.— PAGE 93.

1. How is the bodily house repaired? 2. Who must furnish the material? 3. If we do not furnish the right kind or right quantity, what results? 4. Who is the general manager? 5. What is her business? 6. What is the aorta? 7. How is the aorta divided? 8. How are the arteries divided? 9. How are the arterioles divided? 10. What does capillary mean? 11. How are veins formed? 12. How are the *venæ cavæ* formed? 13. What

do the arteries carry? 14. What do the veins carry? 15. What is the fluid part of the blood called? 16. What does plasma mean? 17. How does the fluid plasma get into the tissues? 18. What is it then called? 19. What are found in this plasma? 20. What is the shape of the red corpuscles? 21. What do they carry? 22. How is the bad or waste material taken out of the body? 23. What prevents blood from running away? 24. How can you see fibrim? 25. Of what importance is fibrim? 26. At what rate does the blood move through the arteries? 27. Through the capillaries? 28. What is there in the veins to keep the blood from going back? 29. What effect has exercise upon the movement of the blood? 30. What effect has breathing? 31. What is a fever?

QUESTIONS ON CHAPTER XV.— PAGE 100.

1. What are the hands and feet? 2. Of what value is the thumb? 3. What are cells? 4. How many kinds of cells? 5. What destroys cell substance? 6. What may you call the cells? 7. What is their work? 8. Where do they get their material? 9. What sort of material do the bone cells use? 10. What do the muscle cells use? 11. What is the first work of the cells? 12. What do they do with the material thus absorbed? 13. What do they do with material that has been used and cast out? 14. What do the cells have to do with the growth of people? 15. What do the liver cells make? 16. What do

the salivary glands make? 17. What do the glands in the stomach make? 18. What do the cells do if the body is wounded? 19. Of what value are salves and ointments? 20. Do cells help each other?

QUESTIONS ON CHAPTER XVI.— PAGE 104.

1. What is located between the windows of the eyes? 2. What is the framework of the nose? 3. How is it divided? 4. With what are these passages lined? 5. Who goes up the stairway? 6. What does she then do? 7. Where is the epiglottis? 8. After passing the epiglottis where does Aura go? 9. How does the trachea differ from the esophagus? 10. How long is the trachea? 11. What is at the top of the trachea? 12. At the bottom? 13. How do the bronchial tubes divide? 14. What is a pulmonary lobule? 15. What do we find here? 16. What wonderful process takes place here? 17. When does "wash day" come in our bodily dwelling? 18. Why do the rings of the esophagus not go all the way around? 19. Why are the walls of the bronchial tubes stiff? 20. What lines these passages? 21. What attendants do we find here? 22. What is their purpose? 23. What are the lungs? 24. How are the ribs attached to the spine? 25. What is the diaphragm? 26. Where is it fastened? 27. How does it act when we breathe? 28. How can we illustrate the movement of the diaphragm? 29. What is the effect of tight clothing? 30. Should man and woman breathe differ-

ently? 31. Can girls have strong muscles? 32. Is it necessary to change the shape of the body to make it beautiful? 33. What is the effect of squeezing the centre of the body? 34. What effect has tight clothing upon the laundry? 35. Upon the force pump? 36. The kitchen? 37. The dining-room? 38. How is the blood made impure? 39. What gases are carried by the red corpuscles? 40. How does the carbonic acid gas get from the blood into the air? 41. How does the oxygen get from the air into the blood? 42. How often do we breathe? 43. Why does a close room give us a headache? 44. How much air do we spoil at a breath? 45. How much air is taken in and given out in moderate breathing? 46. What is this called? 47. When we run, how much more air do we take in? 48. What is this called? 49. What is reserve air? 50. What is residual air? 51. Of what is it composed? 52. When breathing in, how much oxygen and nitrogen does it contain? 53. When breathing out, what is the proportion? 54. What is the effect when we breathe in? 55. How thin are the walls of the air cells? 56. How many are there of them in the lungs? 57. What keeps the outside air pure?

QUESTIONS ON CHAPTER XVII.— PAGE 119.

1. How are some dwellings heated? 2. What makes the fire burn? 3 What is this process called? 4. What is formed by it? 5. What accompanies the chemical process? 6. What is

taken in with every breath? 7. What given out? 8. What might we call the lungs? 9. Why does exercise make us warm? 10. Why are we cold when we sit still? 11. How does the activity of muscle produce heat? 12. How much of the bodily heat is produced by muscular activity? 13. How long does it take the temperature to fall after exercise? 14. What does this teach us? 15. How does digestion affect bodily temperature? 16. What are glands? 17. What is the temperature of the brain of a man who is thinking? 18. What may we call the liver? 19. What does it do? 20. What is excretion? 21. What is secretion? 22. Do clothes make us warm? 23. Which is better, linen, cotton, or woollen for winter wear? 24. What is the bodily temperature in health? 25. When does it reach its greatest height? 26. When is it lowest? 27. What is the office of the skin in regard to the temperature of the body?

QUESTIONS ON CHAPTER XVIII.— PAGE 125.

1. What is a chemist? 2. What changes go on in the body? 3. What particular organ may be called a chemical laboratory? 4. What other names may we give it? 5. Where is the liver located? 6. How held in place? 7. What is the portal circulation? 8. How is the liver made up? 9. What does the liver do with the poisonous materials brought to it? 10. What does the liver manufacture? 11. When is the greatest amount of bile secreted? 12. What increases

the secretion of bile? 13. What is glycogen? 14. How are starchy foods changed before absorption? 15. What effect have the movements of the diaphragm upon the excretion of bile? 16. What is the effect of tight clothing?

QUESTIONS ON CHAPTER XIX.— PAGE 129.

1. Do we understand all parts of our bodily dwelling? 2. What did Aristotle say about the heart? 3. When were the arteries given their names? 4. Why were they called arteries? 5. Who contradicted this idea? 6. What do we call the unknown rooms in our bodily dwelling? 7. What is the name of the two at the back of the reception room? 8. What is the effect of the enlargement of the tonsils? 9. What possibly takes place in the tonsils? 10. What are ductless glands? 11. Where is the thyroid gland? 12. When it is removed, what is the effect? 13. Where is the thymus gland? 14. How long does it increase in size? 15. When does it begin to grow smaller? 16. What is the little cap over the top of each kidney called? 17. What is its office supposed to be? 18. What is the largest of these puzzling rooms? 19. Where is it located? 20. What is it like? 21. What does it do? 22. How many kinds of marrow in bones? 23. Where is yellow marrow found? 24. Where is red marrow found? 25. What power has red marrow?

QUESTIONS ON CHAPTER XX.— PAGE 135.

1. What is the brain? 2. What is located here? 3. What may the nerves be called? 4. Where is the spinal cord? 5. What is the relative position of the white and gray matter in the cord? 6. How many cells in the brain? 7. How many nerves start out from the brain? 8. How many form the spinal cord? 9. What do these nerves form? 10. How many kinds of nerves found in the cerebro-spinal system? 11. What is a ganglion? 12. What is the plural of ganglion? 13. What do the ganglia of the spine do? 14. What special work have different parts of the brain to do? 15. What side of the brain governs the left side of the body? 16. What effect will an injury to the right side of the brain have on the body? 17. What can you tell about the case of the girl who had epilepsy? 18. How did the doctors know where to operate? 19. Give the case in regard to mind-blindness. 20. How was it cured? 21. Where is the area of spoken words? 22. Of what is the cerebrum the center? 23. What does the cerebellum regulate? 24. When an order is sent from the brain to any part of the body how does it get there? 25. From which side of the spinal cord do the nerves of motion issue? 26. The nerves of sensation? 27. How fast does a nerve impulse travel? 28. How do you resemble a telegraph operator?

QUESTIONS ON CHAPTER XXI.—PAGE 142.

1. Tell about the wonderful clock of the World's Fair. 2. About the clock of our wonderful house. 3. What may we call this wonderful clock? 4. What does the sympathetic nervous system govern? 5. Where are these muscles located? 6. Of what is the sympathetic nervous system made up? 7. How many of these ganglia? 8. Where located? 9. How united? 10. What is a plexus? 11. What is the abdominal brain? 12. What is its office? 13. What is the effect when this brain becomes excited? 14. What may the different ganglia of the sympathetic nervous system be called? 15. Where are they found? 16. What effect have they on the heart? 17. On the intestines? 18. On the lungs? 19. What other organs work with rythm?

QUESTIONS ON CHAPTER XXII.—PAGE 146.

1. Where is the regulator of our wonderful clock? 2. What is it called? 3. Of what is it composed? 4. What connects the two divisions of the brain? 5. What does the cerebellum do? 6. What effect has the removal of the cerebellum? 7. How many particular movements do we make in walking? 8. What is the mainspring of our wonderful clock? 9. What does *medulla oblongata* mean? 10. What is the effect when this mainspring is broken? 11. What is the vital knot? 12. Of what is the medulla composed?

13. How large is it? 14. What is a reflex influence? 15. Where do reflex movements originate? 16. Mention some reflex movements? 17. Is breathing reflex?

QUESTIONS ON CHAPTER XXIII.— PAGE 153.

1. What are the watchmen of our bodily dwelling? 2. Where does sight dwell? 3. What are the advantages of seeing? 4. What is the special nerve of sight? 5. What is the nerve of hearing? 6. What are the dangers of deafness? 7. Would you rather be blind or deaf? 8. Where is taste located? 9. What is the special nerve of taste? 10. Do substances taste the same on all parts of the tongue? 11. Illustrate. 12. What is the effect of introducing taste to objectionable substances? 13. Where is smell located? 14. Of what advantage is the sense of smell to a cook? 15. What is the special nerve of smell called? 16. What is sneezing? 17. What enjoyment do you receive from smell? 18. How does it protect us? 19. Where is touch located? 20. What do we learn from the sense of touch? 21. How does touch warn us? 22. What is pain? 23. What is muscular sense? 24. What do we learn from it?

QUESTIONS ON CHAPTER XXIV.— PAGE 161.

1. How many windows in our bodily dwelling? 2. What is hung over them? 3. With what are

the eyelids lined? 4. What is winking? 5. How does winking wash the eye? 6. What keeps the lids from sticking together? 7. Describe the curtain of the window? 8. What is the cornea?

QUESTIONS ON CHAPTER XXV.— PAGE 165.

1. How is a photograph made? 2. What need are shadows in pictures? 3. What does the eye resemble in its structure? 4. What is the shape of the eyeball? 5. What is the vitreous humor? 6. What is the hyaloid membrane? 7. Where is the retina? 8. How many layers has it? 9. What is the choroid coat? 10. Why so called? 11. What is the strong membrane outside of all? 12. How can you illustrate the construction of the eye? 13. Compare the eye and a camera. 14. What is the difference between a convex and a concave lens? 15. What is the office of the ciliary muscles? 16. When is the lens most convex? 17. When does it become flattened? 18. What is the power of the accommodation of the eye? 19. When is a photograph in focus? 20. What is the near point of vision? 21. What is the far point of vision? 22. Why does the eye accommodate most rapidly from a distance to near by? 23. What is it to be far sighted? 24. What is it to be near sighted? 25. What is necessary besides the eye in order that we shall see? 26. What is a blind spot? 27. Prove that you have a blind spot in your eye? 28. What is the yellow spot of the eye? 29. Do

we see a large object all at once? 30. How long can the stimulation of light upon the retina remain after the object is removed? 31. What is the effect of impressions following each other very rapidly? 32. Describe a Zoetrope. 33. Why do we see things upside down? 34. Prove that our perception of objects by sight is a result of education. 35. How can we judge of the solidity of objects? 36. How do we get the idea of perspective? 37. Why do all objects not seem of the same color? 38. Of what color is sunlight? 39. What are the primary colors? 40. If an object lets all the rays of light pass through it, what color would it be? 41. If it allows none to pass, what color? 42. If it absorbs all and reflects none, what color? 43. If it reflects only red rays, what color? 44. What is the explanation of our recognizing different colors? 45. What is color blindness? 46. Is it prevalent? 47. What may cause color blindness?

QUESTIONS ON CHAPTER XXVI.— PAGE 181.

1. What porticos are on the sides of the cupola? 2. What are they for? 3. Who enters here? 4. What does Aura do in the ear? 5. How many passages lead from the throat? 6. How many of these lead into the ear? 7. How is the drum made? 8. What is the tympanum? 9. How does Aura make music on this drum? 10. What queer playthings has Aura in the middle ear? 11. How are they arranged? 12. What

is the cochlea? 13. What are the otoliths? 14. Where is the vestibule? 15. Where is the organ of Corti? 16. How many are there of these fibres? 17. Describe the action of the ear in creating the sense of hearing. 18. How can we distinguish sounds having different quality from each other? 19. What is sympathetic vibration? 20. What is the lowest number of vibrations that we can hear? 21. The highest number?

QUESTIONS ON CHAPTER XXVII.— PAGE 189.

1. What is an orchestrion? 2. Where is our musical instrument located? 3. What is it called? 4. Who plays on it? 5. Describe the larynx. 6. What is the epiglottis? 7. Where are the vocal chords? 8. How is sound made? 9. What do irregular sounds make? 10. Regular sounds? 11. Which has the quickest vibrations, a high note or a low note? 12. How are loud sounds produced? 13. What determines the pitch of tone? 14. Why does the voice change at about fourteen years of age? 15. What affects the quality of the voice? 16. What quality of voice appeals to the better nature? 17. Where is the sounding board of our musical instrument? 18. What is the range of the human voice? 19. What parts of the mouth are used in making vocal sounds? 20. When the orchestrion is silent, what do we call the individual? 21. Why is a person mute? 22. How can deaf children learn to talk?

QUESTIONS ON CHAPTER XXVIII.—PAGE 196.

1. What is the library of our house? 2. When did you begin this library? 3. What kinds of books have you stored there? 4. What is the condition of your arithmetic? 5. Your grammar? 6. Your geography? 7. Have you any dime novels in your library? 8. Can you give this library away? 9. If you have things there you don't want, what can you do with them? 10. How many good words are in your dictionary? 11. How many words will a well educated person use? 12. How many words are there in Shakespeare? 13. How many in the Old Testament? 14. If you should learn a new word a day how many would you learn in a year? 15. How will the libraries of different people differ? 16. What is this library of our bodily house? 17. How can we cultivate our memories? 18. Why will good food help us to remember? 19. Why will failure of the heart power be accompanied by failure of memory? 20. Why will bodily fatigue cause loss of memory? 21. Why does age weaken the memory? 22. Give some rules for educating the memory? 23. Why can we remember an object more clearly if we subject it to investigation of our senses? 24. What is the first rule for improving the memory? 25. The second? 26. The third? 27. The fourth? 28. Fifth? 29. Sixth? 30. Compare memory to photographing.

QUESTIONS ON CHAPTER XXIX.— PAGE 206.

1. What is memory besides a library? 2. What pictures do we store away in our memory gallery? 3. What do we remember most clearly? 4. Illustrate the fact that it is hard sometimes to separate memory pictures from the pictures of imagination. 5. What may we call memory and imagination? 6. What do they do for us?

QUESTIONS ON CHAPTER XXX.— PAGE 209.

1. Can we take friends with us to visit the hidden chambers of our house? 2. What is the Chamber of Hatred? 3. Who paints the pictures in these chambers? 4. What does Imagination paint in the Chamber of Envy? 5. What in the Chamber of Selfishness? 6. What does he paint in the Chamber of Love? 7. What in the Chamber of Peace?

PART II.

QUESTIONS ON CHAPTER I.— PAGE 217.

1. How is a man known? 2. What two kinds of guests visit our house? 3. When the guests are builders, what is the effect on our house? 4. If they are destroyers, what? 5. Who invites the guests to our house? 6. How may man be deceived? 7. Who is the most important food guest? 8. What is the office of oxygen? 9. How much oxygen does a man at rest consume in a day? 10. How does the oxygen enter the lungs? 11. How often should it enter? 12. Who is the second guest that visits us? 13. What is her recommendation? 14. Of what is milk composed? 15. What are the most important albuminoid foods? 16. What are carbo-hydrates? 17. What do they do? 18. What is the standard food? 19. What is one of the most important foods? 20. Why? 21. How much water should one take in a day? 22. What is the difference between organic and inorganic substances? 23. What inorganic substances are found in the body? 24. Where do we get them? 25. What is the use of phosphorus in the system? 26. Where is it found? 27. What is the value of apples? 28. How did the Grecian athletes live? 29. What great men lived without meat? 30. How did the ancient Gauls live? 31. How did they tell when they were eating too much?

QUESTIONS ON CHAPTER II.— PAGE 226.

1. What are the spicy visitors that come to our house? 2. Are they builders? 3. What is the effect of mustard and pepper? 4. Give the history of Alexis St. Martin. 5. What may all condiments be called? 6. What are stimulants? 7. What is the effect of condiments on the digestion?

QUESIONS ON CHAPTER III.— PAGE 231.

1. When was coffee introduced into England? 2. How was it received? 3. What does medical science to-day call coffee? 4. What does Bartholow say of its effect? 5. What does Dr. Emmett say? 6. Is a checking of normal waste desirable? 7. What is the objection to the use of coffee by young people? 8. Give a testimony of intelligent men upon the use of coffee? 9. What may coffee produce in children? 10. When was tea introduced into England? 11. Has any mental work been done without tea or coffee? 12. What is the testimony of John Wesley in regard to tea? 13. Of Dr. Beaumont? 14. What is the effect of tea upon the growth of children?

QUESTIONS ON CHAPTER IV.— PAGE 238.

1. What is the effect of opium upon pain? 2. How does opium quiet pain? 3. What may

the habit of opium use be called? 4. What does the word intoxication mean? 5. What does Coleridge say of opium? 6. What effect has opium upon the moral nature? 7. What effect has chloral hydrate, cocaine, absinthe, hashish, and ginger upon the system?

QUESTIONS ON CHAPTER V.— PAGE 244.

1. Who introduced tobacco to the world? 2. What is his character? 3. What is his effect of introduction into the house? 4. Who are his near relations? 5. When he is dressed in white, and he looks very dainty, what do we call him? 6. What is his character in this guise? 7. What poison does tobacco always carry with him? 8. What is the effect of nicotine? 9. What results if tobacco smoke is passed through a stream of water? 10. In what other forms does tobacco visit the house? 11. Where is the first influence of tobacco felt? 12. Who are supposed to have died from the effects of tobacco? 13. What effect has tobacco upon the bronchial tubes? 14. What is the effect of nicotine on the blood? 15. On the heart? 16. If one tenth of the blood is made of broken down cells what is the result? 17. What is the effect of tobacco upon the intellect? 18. What derangements result from the use of tobacco? 19. What physical derangements? 20. What is the effect on the moral nature? 21. What per cent of school boys use tobacco? 22. Is it dangerous to quit

its use at once? 23. What is the effect of tobacco on the hearing? 24. On the brain? 25. On the nerves? 26. What are the expenses of a man who smokes one hundred cigars a day? 27. Three cigars? 28. How much tobacco is produced in a year? 29. How large a pyramid would this form? 30. What is the yearly expense? 31. What dangers to property result from tobacco using?

QUESTIONS ON CHAPTER VI.— PAGE 269.

1. What does alcohol promise? 2. Under what forms does he ask admission to the bodily house? 3. What is decomposition? 4. What compounds decay rapidly? 5. What accompanies the process of decay? 6. What five things are needed to produce alcohol? 7. How is it formed? 8. What is malt? 9. From what is beer made? 10. Wine? 11. Hard cider? 12. What is distillation? 13. When a housekeeper says a can of fruit has "worked," what does she mean? 14. How is alcohol eliminated from the body? 15. What is a food? 16. How far does alcohol answer this requirement? 17. What is the testimony of Arctic explorers? 18. What experiments have been made by the commander-in-chief of the British army? 19. Demonstrate the relative effects of alcohol and total abstinence on soldiers? 20. What have business organizations discovered in regard to the use of alcohol? 21. What does alcohol do to the body? 22. What effect has it upon digestion? 23. Upon the

mucous membrane? 24. Upon the gastric juice? 25. What is the effect of alcohol on the heart? 26. What organ is first affected by the use of alcohol? 27. What effect has alcohol upon the liver? 28. What effect upon the brain? 29. Upon the power of self-control? 30. What proportion of blood is in the brain? 31. What effect has alcohol on the brain cells? 32. What is the condition of a man who is "dead drunk"? 33. Why is it dangerous for children to use alcohol? 34. Is alcohol a food because it checks waste? 35. How do you prove that alcohol is a destroyer of life? 36. What attitude do insurance companies take in regard to alcohol? 37. What do business men? 38. Why should alcohol not be called a water of life? 39. Is alcohol a tonic? 40. Why not? 41. How many people die every year in the United States as drunkards? 42. How much money is expended in a year in the purchase of alcoholic drinks? 43. What other cost to the United States is the use of alcohol? 44. What does the Bible say in regard to its use?

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